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FRIDAY, MARCH 22, 1907

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

CLOCKS—ANCIENT AND MODERN[1]

Mr. Chairman, Ladies and Gentlemen:

To those who have never had an opportunity to acquaint themselves with the history of the development of the modern clock, I wish to say that no attempt will be made to trace out that development. Time will not permit, as those familiar with the subject well know. I only wish to call to your attention a few points that I hope may be of general interest.

In Nepal, a small independent state situated on the northeastern frontier of Hindustan, there is still practised what is one of the crudest and probably earliest methods of measuring time. A copper vessel with a small hole in the bottom floats on water, sinks and fills sixty times a day. Each time it fills a gong, or ghari, is struck, in progressive numbers from dawn to noon; after noon the first gong struck indicates the number of gharis which remain of the day until sunset. Day is considered to begin when the tiles of a house can be counted or when the hairs on the back of a man's hand can be discerned against the sky. The day is divided into 60 gharis of 24 minutes each, each ghari into 60 palas and each pala into 60 bipalas.

Leaving India for Sumatra and stepping aboard a Malay proa we should there find, floating in a bucket of water, a cocoanut shell having a small perforation, through

[1] Address of the retiring vice-president of Section A, American Association for the Advancement of Science.

which the water by slow degrees finds its way into the interior. When the shell fills and sinks, the man on watch calls the time and sets it afloat again.

The gradual development through untold ages of the floating copper vessel has given us our finest astronomical clocks of to-day, and similarly the floating cocoanut shell may be considered the simplest form of a marine chronometer.

If now we visit the Chinese Empire we find in use there also the water clock, but instead of the water flowing into a vessel through a small hole in the bottom, it flows out of the hole. In attempting to calibrate such a vessel so that any given portion of the whole time required to empty it might be determined, it is at once noticed that when the vessel is nearly full the water flows out more rapidly than when it is nearly empty. The difficulty here presented is most easily overcome by keeping the vessel filled with water when the flow will be uniform, and catching the discharged water in a cylindrical vessel in which the surface of the water will rise equal distances in equal times. Chinese writers ascribe the invention of this instrument, called a clepsydra, to Hwang-ti, who lived more than twenty-five centuries before our era. About fourteen centuries later Duke Chau introduced a float upon the surface of the water in the final cylinder by means of which an indicator was made to travel over an adjacent scale as the water rose in the cylinder, thus allowing the indications of the instrument to be perceived at a greater distance.

These instruments that have just been described may be called artificial timekeepers, and are used primarily to subdivide the day, while the sundial of equal antiquity with the others may be called a natural timekeeper, as it gives a means of determining day after day a particular time of day, such as apparent noon.

The earliest mention of a sundial is found in Isaiah 38: 8, in connection with the promise of the Lord to add fifteen years to the life of Hezekiah who lived about 2,600 years ago. "And this shall be a sign unto thee from the Lord, that the Lord will do this thing that he hath spoken; behold, I will bring again the shadow of the degrees, which is gone down in the sundial of Ahaz, ten degrees backward. So the sun returned ten degrees, by which degrees it was gone down."

Of the nature of this sundial nothing is said, nor is there found any description of such an instrument until 350 years later, when we find the sundial of the Chaldean priest Berosus, who lived in the time of Alexander the Great and his immediate successors.

This consisted of a hollow hemisphere placed with its rim perfectly horizontal, and having a bead fixed at its center. So long as the sun remained above the horizon the shadow of the bead would fall on the inside of the hemisphere, and the path of the shadow during the day would be approximately a circular arc. This arc, divided into twelve equal parts, determined twelve equal intervals of time for that day. Now supposing this were done at the time of the solstices and equinoxes, and on as many intermediate days as might be considered sufficient, and then curve lines drawn through the corresponding points of division of the different arcs, the shadow of the bead falling on one of these curve lines would mark a division of time for that day, and thus we should have a sundial which would divide each period of daylight into twelve equal parts. These equal parts were called *temporary hours;* and since the duration of daylight varies from day to day, the temporary hours of one day would differ in length from those of another. Dials of this form were still used by the Arabians a thousand years ago,

and about 1750 four such were found in Italy.

The introduction of the sundial into Greece is generally fixed by historians in the latter part of the sixth century B.C. At that time the instrument seems to have been a very crude one, consisting merely of a pillar without any graduated dial by means of which the day could be divided into a number of equal parts. The length of the shadow determined the time for certain regular daily duties, as a shadow six feet long might indicate the time for bathing, and one twelve feet long that for supper.

As civilization advanced and the needs of the people required more accurate measures of time, the sundial was developed. We have already mentioned the sundial of Berosus, about 350 B.C., by means of which each day from sunrise to sunset was divided into twelve equal parts, that is provided the sun was visible all day long.

As the sundial could not be used indoors or on cloudy days, as soon as the Grecian life became complex enough to need a timepiece under such circumstances, this demand was met by the clepsydra. The time of its introduction is not definitely known, but the familiar references of Aristophanes show its use to have been common about 430 B.C., while no mention is made of it by Herodotus, whose history ends fifty years earlier.

A passage in Aristotle gives some idea of the early form of the clepsydra: it was a spherical bottle with a minute opening at the bottom and a short neck at the top into which the water was poured, and by closing which the flow of the water could be stopped. This form of clepsydra became a necessary adjunct of all courts of justice, and the number of gallons of water that a lawyer was allowed for his speech gave some indication of the importance of the trial. In fact, the word *ὕδωρ* became a synonym for time. We find Demosthenes charging his opponent with talking 'in my water'; and on another occasion he shows the value he attached to the time allotted him by turning to the officer, when interrupted, with a peremptory 'You there! stop the water!' reminding one of the 'take out time' of our modern football contests.

The first timepiece of the Romans seems to have been the watchman, who, from the Senate House, called forth noon as soon as he caught sight of the sun between the Rostra and the Græco-Statis. From the same point he watched the declining sun and proclaimed its disappearance. This custom was probably instituted towards the close of the fifth century B.C. According to Pliny the first sundial was set up in Rome about 290 B.C. About thirty years later Consul Valerius Messala erected at Rome a sundial which was captured at Catania in Sicily. This instrument was not a mere gnomen such as was introduced three centuries earlier into Greece, but was the result of Grecian science and genius, constructed for a particular latitude, that of Catania 5° south of Rome. For a hundred years this sundial supplied the needs of the Romans for a timepiece, although it was constantly in error. Finally, in 164 B.C., Marcius Phillippus set up near the dial of Catania, one constructed for the latitude of Rome, and Rome then possessed her first accurate timepiece; and during the time of Plautus the use of sundials became common, as is evidenced by the following quotation:

When I was young, no time-piece Rome supplied,
  But every fellow had his own—inside;
A trusty horologe, that—rain or shine—
  Ne'er failed to warn him of the hour—to dine,
Then sturdy Romans sauntered through the Forum,
  Fat, hale, content; for trouble ne'er came o'er them,

But *now* these cursed dials show their faces,
All over Rome in streets and public places;
And men, to know the hour, the cold stone question,
That has no heart, no stomach, no digestion,
They watch the creeping shadows—daily thinner—
Shadows themselves, impatient for their dinner.
Give me the good old time-piece, if you please,
Confound the villain that invented these!

As in Greece so in Rome, the clepsydra followed in the wake of the sundial, and as in the case of the sundial, Grecian science and genius had by this time produced a much more perfect instrument than that first used by the Greeks.

In describing the sundial of Berosus, I stated that by it the day was divided from sunrise to sunset into twelve parts, varying in lengths from day to day, called temporary hours. If now the clepsydra and the sundial were to read alike, it was necessary that the hours recorded by the clepsydra should also change from day to day. Various devices were adopted to accomplish this. Further, as the clepsydra could be used throughout the entire day and night, it was necessary to have it record hours of a different length at night from what it did in the day, as each night, *i. e.*, from sunset to sunrise, was divided into twelve hours as well as each day.

Fig. 1 represents an early form of the clepsydra. It consists of an inverted cone *A*, with a small aperture at its vertex. The water is supplied through the pipe *H* and is prevented from rising above a fixed level in *A* by the waste pipe *I*, which carries off the superfluous water. Thus there will be a uniform flow of water from the vertex of the cone into the cylindrical vessel and the cork *F* will rise uniformly, communicating its motion through the rod *E* to the hand *G*, which indicates the hours on the dial. In order to produce a change in the rate of flow of the water from the conical vessel, as is necessary in having the hand indicate hours of different length from day to day, a solid cone *B*, similar to *A*, was plunged into the hollow one, and its position for any given day or night was indicated by the coincidence of a particular one of the adjusting marks on the stem *D* with the top cross-piece of the frame *C*.

A later form of clepsydra, attributed to Ctesibius, who lived during the latter part of the third century B.C., is shown in Fig. 2. *A* is the end of a tube over which an image stands, which is connected with a full reservoir, and from the eyes of which, considered as invariable apertures, the water continually flows or drops in a regulated manner into it; this tube conveys the water into

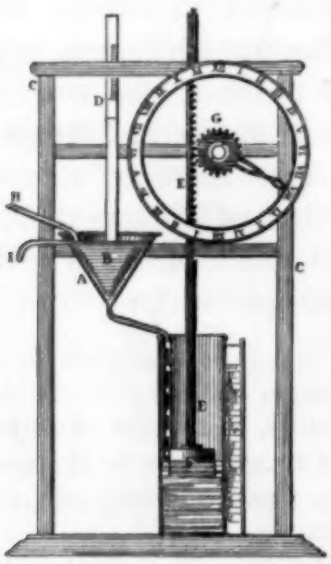


Fig. 1. Early Form of Clepsydra.

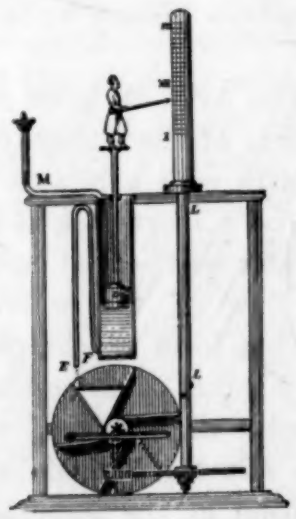


Fig. 2. Clepsydra of Ctesibius.

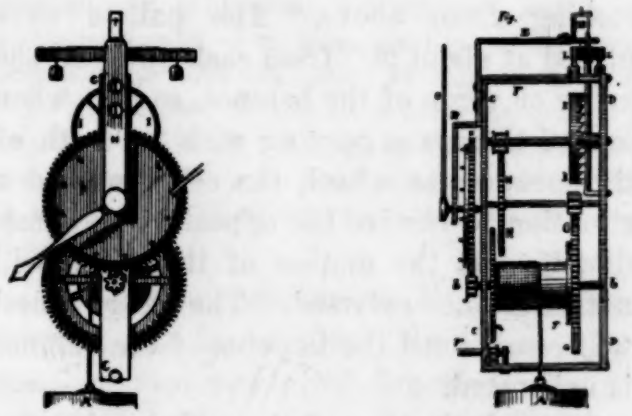
the top of the cylindrical vessel *BCDF*, which gradually fills, the cork *D*, with its attached pillar *C*, rising at the same time. On the top of this pillar is an image holding an index which points to the divisions on the large column above. Now when the water rises in the cylindrical vessel it also rises in the small tube *FB*, which constitutes one leg of a syphon; consequently, when the small tube fills and the index has mounted to the top of the large column, the water flows over the bent part *B* of the syphon and the vessel is emptied into one of the six troughs of the waterwheel *K*, which is thus turned one sixth of a revolution, and the column, by means of the gearing shown in the figure, 1/365 of a revolution, during which time the image falls with its index to the bottom of the column, to be ready for the next day. There are ruled around the large column twenty-five lines properly sloped with respect to each other, so that the index may indicate the hour on any day of the year.

For the next fifteen centuries or more after the introduction of this clepsydra of Ctesibius, sundials and clepsydras were the timekeepers of mankind. These were then gradually supplanted by weight clocks.

I am not able to give the date of the manufacture of the first clock composed of an assemblage of wheels actuated by a suspended gravitating body and controlled by a regulator of some determined shape and dimensions, *i. e.*, a regulated machine for measuring time without the assistance of water.

There may be seen at the South Kensington Museum an old clock movement, now controlled by a pendulum, which was removed about seventy years ago from a clock in Wells Cathedral and which is said to have been built by Peter Lightfoot, about 1335, for the church of Glastonbury Abbey, from which it was removed to Wells Cathedral in the reign of Henry VIII., where, I believe, the dial and its accessories may now be seen. In addition to indicating the time, this clock was intended to indicate the age of the moon and to show its phase. Also it caused a man to strike the quarter hours with his feet on two little bells, and the hours on another bell before him with a battle-axe that is in his hand. It also set in motion four equestrian knights equipped for a tournament. If the date given for the clock is correct the figures operated in connection with it are hardly the original ones. One of the knights is painted in the civil costume of the seventeenth century.

About 1360 there was erected in the tower of the palace of Charles V. of France a clock constructed by Henry de Vick, of Würtemberg. This clock was made for the simple purpose of telling the time of day and was not expected to perform the numerous feats that were so frequently required of clocks in earlier days, and may be taken as a type of the earliest clock movements.



Front view. Side view.

FIG. 3. Ancient Clock by Henry de Vick.

From Fig. 3, giving both a front and a side view, the operation of the clock may be clearly understood. The motion of the falling weight *A* is transmitted by means of the wheels *G*, *e*, *H* and *g* to the wheel *I*; this last wheel, by giving the pallets or short levers, *h*, *i*, each a push alternately by two teeth, at opposite sides of its cir-

cumference, and moving in opposite directions, one forward and the other backward, gives a vibratory motion to the vertical arbor K, and as the regulator or balance was fixed on this arbor, it was thus made to vibrate backwards and forwards at every push of the escapement wheel upon the pallets, the period of the vibration being regulated by the position of the small weights m, m on its arms. Thus the whole duration of a vibration was the measure of time, and the wheels and pinions were employed first to transmit the maintaining power to the balance, and secondly to number the vibrations and indicate them in visible form by a hand O on a dial plate.

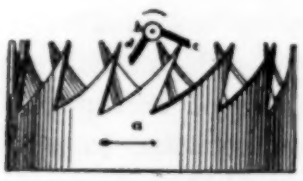


FIG. 4. View of de Vick's Escapement Wheel from above.

Fig. 4 gives a view of the escapement wheel looking from above. The pallets were placed at about 90° from each other on the arbor or verge of the balance, so that when one of them was parting with its tooth of the escapement wheel, the other was in a situation to receive the opposite one immediately, but the motion of the verge will not be at once reversed. The escape wheel will recoil until the impetus of the balance is exhausted.

The substitution of the main spring for a large heavy body as a first mover constituted a second era in modern horology, from which we may date the origin of the fusee, or mechanism for equalizing the variable power of a coiled spring.

While the date at which the first portable clock was made may not be definitely stated, it was certainly as early as 1525, as the Society of Antiquaries in England has in its possession one made in that year by Jacob Zech at Prague, the inventor of the fusee. Its construction differs materially from that of De Vick's clock only in that it has a spiral spring with a fusee instead of the driving weight.

Such was the state of clockwork when Galileo, the celebrated philosopher and mathematician, while watching the vibrations of the great bronze lamp swinging from the roof of the cathedral of Pisa in 1583 observed that, whatever the range of its oscillations, they were invariably executed in equal times. Because of this isochronal property of a vibrating suspended body the pendulum was introduced as the regulator of clockwork, thus inaugurating the third era in the development of the modern clock.

The honor of being the first to apply a pendulum as a regulator of clockwork is claimed for several clock-makers.

The earliest of these is, I believe, Richard Harris, who is said to have made a pendulum clock for St. Paul's Church, Covent Garden, in 1641. Vincent Galileo claims to have applied his father's discovery to the construction of a pendulum clock in 1649, but does not seem to have made the fact public until after Huyghens in 1657 presented to the States of Holland a clock controlled by a pendulum, claiming for himself the invention of this form of control. Certain it is that Huyghens gave much study to the mathematical theory of the pendulum, and proved that in order that pendulum vibrations of different lengths should be strictly isochronal, the pendulum should vibrate between cycloidal checks. Such an arrangement he introduced into his clock of 1657, which also contained the famous Huyghens loop in connection with the winding apparatus.

With the verge escapement, Fig. 4, the one in use when the pendulum was applied to clockwork, and which required a long arc of vibration for the escapement of the

escapement wheel, the deviation of the circular arc described by an ordinary pendulum from the theoretical cycloidal arc was, of necessity, taken into account. With the introduction of the anchor or recoil escapement, Fig. 5, invented by Dr. Hooke in about 1675, the long swing of the pendulum was obviated and the cycloidal cheeks were found to be more detrimental than advantageous.

The expansion of metals by heat has been known ever since the middle of the seventeenth century, and early in the eighteenth George Graham set himself the task of making a clock pendulum such that the distance between the center of oscillation and the center of suspension would be independent of the temperature. I quote from his paper 'A Contrivance to avoid Irregularities in a Clock's Motion by the Action of Heat and Cold upon the Pendulum,' communicated to the Royal Society in 1726:

> Whereas several who have been curious in measuring time have taken notice that the vibrations of a pendulum are slower in summer than in winter, and have very justly supposed this alteration has proceeded from a change of length in the pendulum itself, by the influence of heat and cold upon it, in the different seasons of the year; with a view, therefore, of correcting, in some degree, this defect of the pendulum, I made several trials, about the year 1715, to discover whether there was any considerable difference of expansion between brass, steel, iron, copper, silver, etc., when exposed to the same degree of heat as nearly as I could determine, conceiving it would not be very difficult, by making use of two sorts of metals, differing considerably in their degrees of expansion and contraction, to remedy, in great measure, the irregularities to which common pendulums are subject. But although it is easily discoverable that all these metals suffer a sensible alteration of their dimensions by heat and cold, yet I found their differences in quantity from one another were so small, as gave me no hopes of succeeding this way, and made me leave off prosecuting this affair any further at that time. In the beginning of December, 1721, having occasion for an exact level, besides other materials I made trial of, quicksilver was one; which, although I found it was by no means proper for a level, yet the extraordinary degree of expansion that I observed in it when placed near the fire, beyond what I had conceived to be in so dense a fluid, immediately suggested to me the use that might be made of it by applying it to a pendulum. In a few days after I made the experiment, but with much too long a column of quicksilver, the clock going slower with an increase of cold, contrary to the common pendulum; however, it was a great confirmation of the advantage to be expected from it, since it was easy to shorten the column in any degree required.

As his first jar was too long, so his second was too short, but by June 9, 1722, he was ready to test the running of his mercury pendulum clock with one regulated by an uncompensated pendulum. He says:

> For the first year I wrote down every day the difference between the two clocks, with the height of the thermometer, not omitting the transits of the stars as often as it was clear. The result of all the observations was this, that the irregularity of the clock with the quicksilver pendulum, compared with the transits of the stars, exceeded not, when greatest, a sixth part of that of the other clock with the common pendulum; but for the greatest part of the year, not above an eighth or ninth part, and even this quantity would have been lessened had the pillar of mercury been a little shorter, for it differed a little the contrary way from the other clock, going faster with heat, and slower with cold; but I made no alteration in length to avoid an interruption of the observations.

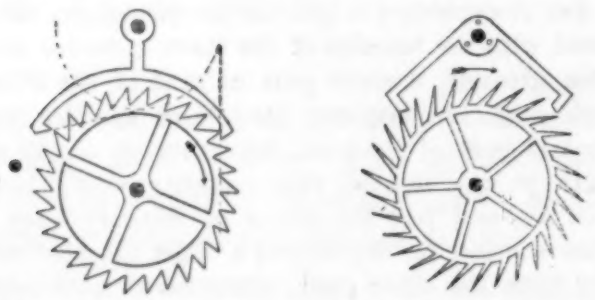
A few years afterward John Harrison brought out his gridiron pendulum composed of four brass and five steel rods, so constructed that the expansion of the steel rods tended to lower the pendulum bob while the expansion of the brass ones tended to raise it.

Another form of compensated pendulum that has found favor is the zinc-tube pendulum, in which the zinc tube surrounds a rod of steel and is itself surrounded by a tube of steel. Here the zinc tube fulfils the purpose of the brass rods in the gridiron pendulum. At present at least one

firm of clock manufacturers is using invar or nickel steel for its pendulum rods.

Attempts have also been made to compensate a pendulum to avoid changes in the rate due to changes of the barometer. At Greenwich this is accomplished by attaching a magnet to the end of the pendulum and causing a second magnet supported below the pendulum to approach or recede from the pendulum with changes of the barometer. This second magnet increases the acceleration due to gravity to a greater or less degree as it approaches or recedes from the pendulum.

The most satisfactory way, however, of freeing a clock rate from variations due to changes of temperature and pressure is to enclose the clock in an air-tight glass case kept in a room of constant temperature. A number of observatories now keep their standard clocks under such conditions.



Anchor or Recoil Escapement. Dead-beat Escapement.

Fig. 5.

Another improvement in the manufacture of clocks was accomplished by Graham in the introduction of the dead-beat escapement.

In Fig. 5 are shown both the anchor or recoil escapement and the dead-beat escapement. In the first, shown on the left, the pendulum moving to the left has just escaped a tooth at the left-hand pallet and allowed a tooth to fall on the right-hand one. The pendulum, however, still continues its swing to the left, and in consequence the pallet pushes the wheel back, thus causing the recoil that gives the name to the escapement. It is only after the pendulum comes to rest and begins its excursion the other way that it gets any assistance from the wheel, and the difference between the forward motion of the wheel and its recoil forms the impulse. In the right-hand figure, the pendulum moving to the right has just escaped a tooth from the right-hand pallet while another has fallen upon the left-hand one. As the pendulum continues its motion towards the right, the left hand-pallet slides over the point of the tooth, but there is no recoil, as the 'dead' face, as it is called, is the arc of a circle whose center is the point about which the anchor turns. As the pendulum returns towards the left, the tooth traverses the 'dead' face in the opposite direction, and immediately upon leaving this face it passes to the 'impulse' face, and while passing along this face gives the impulse to the pendulum.

The great advantage of the dead-beat escapement over the anchor or recoil type is that, although a slight increase of force on the escapement wheel increases the arc of the pendulum, it does not sensibly increase the time, while the time does sensibly increase with the recoil escapement.

At about this time also, Mudge introduced the gravity escapement. With all the previous escapements the impulse was given to the pendulum by the driving weight acting through the train so that any irregularities in the train would cause a variation in the impulse. With the gravity escapement a weight is raised by the train and the falling of this weight gives the impulse to the pendulum. We thus have a uniform impulse at each oscillation due to the falling of a weight through a fixed distance. Simple and elegant as is this theory, the application of it gave a great deal of trouble and all gravity escapements were regarded with suspicion, as having a tendency to trip, until Mr. Denison designed

the double three-leg one for the great clock at the Houses of Parliament about fifty years ago. Incidentally, it might be mentioned that this Westminster clock has turned out to be the finest timekeeper of any public clock in the world. The original specifications required that the clock should be guaranteed to perform within a margin of a minute a week, which caused the leading clock-makers of England to decline to bid for the work. However, under Mr. Denison's supervision the clock was built by Mr. Dent, and from reports of the Astronomer Royal, who receives at Greenwich two signals a day from this clock, sent automatically, its error is rarely over a second a week.

The Denison gravity escapement is shown in Fig. 6. This escapement consists of two gravity-impulse pallets pivoted as nearly as possible in a line with the bending point of the pendulum spring and touching the pendulum near the bottom of the figure. The locking wheel is made up of two thin plates having three long teeth or 'legs' each. These two plates are squared on the arbor a little distance apart, one on each side of the pallets. Between them are three pins which lift the pallets. In the figure, one of the front legs is resting on a block screwed to the front of the right-hand pallet. There is a similar block screwed to the back of the left-hand pallet for the legs of the back-plate, which is shaded in the figure, to lock upon. Projecting inward from each of the pallets is an arm. The tip of the one on the right-hand pallet is just in contact with one of the pins which has lifted the pallet to the position shown. The pendulum is traveling in the direction indicated by the arrow, and the left-hand pallet has just given impulse. The pendulum rod in its swing will push the right-hand pallet far enough for the leg of the front locking plate, which is now resting on the block, to escape. Directly it escapes, the left-hand pallet is lifted free of the pendulum rod by the lowest of the three pins. After the locking wheel has passed through 60°, a leg of the back locking plate is caught by the locking block on the left-hand pallet. As the three-leaved pinion always lifts the pallets the same distance, the pallets in returning give a constant impulse to the pendulum.

FIG. 6. Denison Gravity Escapement.

About fifteen or twenty years ago the Rieflers, clockmakers of Munich, introduced into their clocks an escapement in which the impulse is communicated to the pendulum through the suspension spring. The pendulum is supported by a rocking frame to which is attached the anchor carrying the pallets which are acted upon by the escapement wheel. Just after the pendulum has passed through its vertical position, the escapement wheel, when released, gives to the supporting frame of the pendulum suspension spring a slight tilt in the opposite direction from that in which the pendulum is moving, thus increasing the tension of the spring due to the swing of the pendulum to one side.

In the next few minutes I wish to consider the accuracy with which our astronomical clocks perform their function.

The earliest star catalogue of precision is that of Bradley and the observations upon which it is based were made about a third of a century after the introduction of the compensated pendulum. In discuss-

ing the performance of his clock, I have used the adopted rates as given by Auwers in his rereduction of Bradley. The monthly means of the rates from July, 1758, to July, 1759, were taken and the difference of each rate from its monthly mean. Then the mean of these differences without regard to sign was taken for each month.

VARIATION OF DAILY RATE OF THREE GREENWICH SIDEREAL CLOCKS

Bradley's Clock			Sidereal Stand. "Hardy"			Sidereal Stand. "Dent"		
Date	Daily Rate	Mean Residual	Date	Daily Rate	Mean Residual	Date	Daily Rate	Mean Residual
1758	s	s	1850	s	s	1900	s	s
July	−0.086	0.060	January	+0.666	0.269	January	+0.280	0.035
August	+0.012	0.079	February	+0.857	0.162	February	+0.196	0.041
September	−0.012	0.077	March	+0.930	0.117	March	+0.170	0.038
October	−0.130	0.166	April	+1.154	0.257	April	+0.134	0.027
November	−0.094	0.127	May	+1.607	0.105	May	+0.078	0.028
December	−0.190	0.096	June	+1.372	0.117	June	+0.022	0.045
1759								
January	−0.264	0.106	July	+1.058	0.202	July	−0.096	0.039
February	−0.343	0.072	August	+0.821	0.104	August	−0.245	0.053
March	−0.449	0.108	September	+1.003	0.087	September	−0.381	0.056
April	−0.310	0.125	October	+1.049	0.120	October	−0.549	0.048
May	−0.322	0.127	November	+1.232	0.063	November	−0.522	0.161
June	−0.439	0.086	December	+1.389	0.187	December	−0.259	0.036
Mean		0.102	Mean		0.149	Mean		0.051

The rates of two other clocks of the Greenwich Observatory were likewise discussed, the standard clock for the year 1850 and that for 1900, the adopted daily rates as published in the annual volumes being used. The first of these was kept in the observing room and thereby subjected to large variations of temperature, while the second, made in 1871 by E. Dent and Company, was fixed to the north wall of the magnetic basement, as in this apartment the temperature is kept nearly uniform. The pendulum of this latter clock is provided with barometric as well as thermometric compensation.

I sought to make a similar comparison for the clocks of the other large observatories, but soon found that the information concerning the performance of the various clocks was given in such a form that it was in almost every case either impossible or extremely laborious to secure the desired result. However, there are two well-known clocks which should be mentioned in this connection, and in conclusion I will give some hitherto unpublished data concerning the clock with which I have been working during the past three years.

Probably no clock has had its rate more thoroughly discussed than Hohwü No. 17, the standard clock of the observatory at Leiden.

It was set up in the transit room in 1861 and in December, 1898, was removed to the large hall of the observatory, where, enclosed in two wooden cases, it was placed in a niche cut in the pier of the ten-inch refractor. To further guard against sudden changes of temperature the niche is closed by a glass door. At the meeting of the Royal Academy of Sciences at Amsterdam, held September 27, 1902, Dr. E. F. van de Sande Bakhuyzen submitted the following formula as the best representation of the daily rate of the clock:

$$\begin{aligned}\text{Daily rate} = &-0^s.173 + 0^s.0157\,(h - 760^{mm}) \\ &- 0^s.0253\,(t - 10^\circ) + 0^s.00074\,(t - 10^\circ)^2 \\ &+ 0^s.0465\,\cos 2\pi\,(T - \text{May } 3)/365\end{aligned}$$

and gave the result of a comparison of the observed daily rates 1899–1902, the average interval of time for each rate being six

days, with those computed by means of the above formula. I find during the year 1900 the mean of these difference is 0ˢ.028 and the largest difference is 0ˢ.071.

About 1867 F. Tiede installed at the Berlin Observatory a weight-driven clock enclosed in an air-tight case. The original escapement was replaced in 1876 by a gravity escapement and the clock has continued to give satisfaction, certainly up until 1902, when it was dismounted for cleaning. The only published rates that I have been able to secure are those during twelve weeks in 1877–8. During this period the average deviation of the observed daily rates, the average interval for each rate being six days, from the mean daily rate for the entire period is 0ˢ.030.

In connection with the publication of these rates[2] the statement is made that for weeks at a time this mean deviation will not exceed 0ˢ.02.

DAILY RATE OF RIEFLER SIDEREAL CLOCK NO. 70.

Date	Daily Rate	Mean Barometer	Mean Temp.	Computed Rate	O—C.
1904	s.	mm.	°	s.	s.
Feb. 8–11	+0.019	631.0	28.3 C.	+0.009	+0.010
11–15	—0.014	631.5	28.5	—0.006	—0.008
15–20	+0.005	631.5	28.3	—0.002	+0.007
Mar. 1– 4	—0.026	631.0	28.2	—0.012	—0.014
4– 9	—0.010	631.0	28.2	—0.016	+0.006
9–16	—0.022	631.5	28.1	—0.018	—0.004
16–18	—0.043	631.0	28.1	—0.022	—0.021
18–22	—0.022	631.0	28.0	—0.021	—0.001
22–25	—0.029	631.0	28.0	—0.024	—0.005
25–28	+0.002	631.0	27.7	—0.014	+0.016
28–34	—0.007	631.0	27.7	—0.018	+0.011
Apr. 3– 5	+0.017	631.0	27.4	—0.009	+0.026
5–13	+0.002	631.0	26.9	+0.014	—0.012
13–16	+0.026	631.0	26.5	+0.021	+0.005
16–19	+0.034	631.0	26.3	+0.027	+0.007
19–22	+0.002	631.0	26.4	+0.020	—0.018
22–31	+0.029	631.0	25.0	+0.077	—0.048
May 1– 4	+0.113	631.5	24.3	+0.103	+0.010
4– 7	+0.082	631.0	24.1	+0.109	—0.027
7–12	+0.161	631.0	24.0	+0.109	+0.052
				Mean	±0.015

In 1903 there was installed at the Naval Observatory one of Riefler's clocks, No. 70, with a nickel-steel pendulum, the impulse being communicated to the pendulum through the suspension spring. This clock was enclosed in an air-tight glass case and was mounted in a vault where the temperature was artificially controlled. The definitive rates have been determined from September, 1903, to May, 1904, but, unfortunately, during this entire period we were unable to prevent the glass case leaking and there was a variation of temperature in the vault of about 5° C. However, from the first of February to the middle of May the pressure was kept nearly constant by reducing it each day by means of an air pump by from 1 to 2 millimeters. During this period the following results were obtained:

The formula from which the computed rate is obtained,

$$\text{Daily rate} = +0^{s}.0161 - 0^{s}.00103\,(T - \text{Mar. } 29.0) - 0^{s}.0456\,(t - 27°.0)$$

is the result of a least square solution of the twenty observed rates.

Collecting together the results given above, we have:

MEAN DEVIATION OF DAILY CLOCK RATE.

Clock	Date	Mean Deviation
Bradley	1759	0.102
Greenwich Observatory	1850	0.149
Greenwich Observatory	1900	0.051
Berlin Observatory	1877	0.02–0.03
Leiden Observatory	1900	0.028
U. S. Naval Observatory	1904	0.015

In considering this table I hope the particular method by which each of the numbers given was obtained will be remembered. The reason for using different methods has already been given. If the rates of the first three clocks had been treated in a manner similar to that used in the last three cases, the numbers given might have been slightly smaller, and if the period under consideration with the Berlin and Washington clocks had been

[2] A. N. Nr. 2184.

longer the two corresponding residuals might have been slightly larger.

W. S. Eichelberger
U. S. Naval Observatory

THE NEW YORK MEETING OF SECTION C OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND THE THIRTY-FIFTH GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY—II.

BIOLOGICAL CHEMISTRY

Wm. J. Gies, Chairman

The Rational Conversion of Energy: J. E. Siebel, Jr.

The Thermodynamics of Nutrition: J. E. Siebel, Jr.

The Effects of Magnesium Sulphate upon Seedlings: Gertrude Burlingham.

From extended experiments upon the growth of seedlings in dilute solutions of magnesium sulphate, it was found that while it is usually toxic in strengths greater than *M*/8192 (0.003 per cent.), it produces decided stimulation in *M*/16384, reaches a maximum stimulation at dilutions from *M*/32768 to *M*/131072 (0.00075 per cent. to 0.00018 per cent.), then beyond this point gradually diminishes in action. The point of toxicity and of greatest stimulation varies with the type of seedling. Both the plumule and the roots attain greater growth in these favorable dilutions of magnesium sulphate and in the control of distilled water, and often the lateral roots develop two or three days sooner. While growth in the control practically stops at the end of one week, it continues from four to five weeks in the magnesium sulphate cultures. Two parallel series, one magnesium sulphate and control, the other calcium nitrate and control, in dilutions from *M*/8192, *M*/16384, etc., to *M*/262144, showed that calcium ceases to be stimulating in the dilution in which magnesium loses its toxicity and produces maximum stimulation; in *M*/32768 magnesium sulphate the root growth is eight times that in calcium nitrate. In every instance after the renewal of the solutions, growth was accelerated in the magnesium cultures, while there was little change in the control. Seedlings allowed to grow for several weeks in a dilution of magnesium sulphate which was at first slightly toxic, finally developed strong lateral roots and attained a root growth far beyond the control. These results show conclusively that magnesium sulphate in proper dilution is beneficial to the growth of seedlings, and that any inhibitory effects are due to the presence of excessive amounts, thus controverting Loew's theory that magnesium salts when alone in solution are always injurious to plant growth.

Chronic Arsenical Poisoning and the Distribution of Arsenic in the Animal Organism: Wm. D. Harkins.

In copper smelting regions arsenic is likely to be a constituent of grass, hay, and all the organs of animals. Grass has been found to contain as high as 1,500 parts of arsenic trioxide, and the ulcers in the noses of horses as high as 1,000 parts per million. 0.362 Gram of arsenic trioxide killed a sheep in eight days, 0.123 gram of sodium arsenite killed a sheep in thirty-three days with thirty-one pounds loss of weight, and 0.055 gram in sixty-nine days with ten pounds loss in weight.

On Proteose Fever: R. B. Gibson.

Fever has been considered to result from the injection of prepared proteoses and of bacterial endo- and extra-cellular proteose-like substances, especially as albumosuria is often observed in septic and aseptic fevers of experimental or natural origin. As yet no observations have been made with proteoses prepared from highly purified or crystalline proteids. Pepsin-HCl

proteoses were prepared as usual, but without subjecting the products to temperatures over 50° C., from repeatedly precipitated caseinogen, recrystallized egg albumin and recrystallized edestin. Proteoses soluble and insoluble in 95 per cent. alcohol were obtained from each. Bromelin and papain caseoses were also employed. The proteoses were injected in doses of 0.3 to 0.7 gm. into guinea-pigs and 0.5 to 1.2 gm. into rabbits; the temperature variations were observed on several days previous to the injection and were controlled by saline injections. The bromelin and papain caseoses and egg albumin proteoses have at times caused slight rise of temperature, while the purest material—the edestinose—has been practically without effects whenever tried. Extraction of the bromelin and papain caseoses with boiling alcohol has lessened the pyrexia, and the products soluble in 95 per cent. alcohol were found non-febrile. The primary cleavage products of pepsin-HCl digestion, when prepared as above, never have more than a slight pyrogenic effect when injected into rabbits and guinea pigs. This effect is so slight that such substances can not be the direct inciting cause of the severe naturally occurring fevers.

The Fractional Precipitation of Antitoxic Serum: E. J. BANZHAF and R. B. GIBSON.

A new practical method for the partial purification and concentration of antitoxin, based on the solubility of antitoxic proteids in saturated NaCl solution. The diluted plasma is precipitated with an equal volume of saturated $(NH_4)_2SO_4$ solution and the antitoxic proteids extracted from the precipitate with saturated NaCl. The method has been used to study further the concentration of antitoxin. Twenty liters of plasma (475 units per c.c.) were diluted with 20 liters of water; by fractioning with $(NH_4)_2SO_4$, the three proteid precipitates were obtained containing 1,150, 1,350 and 1,750 units, respectively, per c.c. The NaCl-soluble (total antitoxic) globulins of these fractions of the plasma were prepared as usual.

A second experiment resulted similarly. All the preparations, when precipitated from the NaCl with acetic acid and dialyzed, probably contained a partially denaturalized antitoxic globulin, which had a diminished solubility and antitoxic potency (per gm.) and was precipitated on slight acidification by great dilution. Further partition (after complete neutralization) of the fractions when freed from the water-acid precipitable proteid yielded filtrates that coagulated at 73° C. The more soluble proteids of the fractions were found to have a relatively higher antitoxic content per gm., the last to be precipitated being at least three to four times stronger than the total NaCl-soluble globulin.

Some Factors Modifying the Output of Endogenous Uric Acid: E. W. ROCKWOOD and C. VAN EPPS.

An attempt was made to determine the effect of some substances commonly used to increase the elimination of uric acid by man; at the same time the nitrogen, phosphoric acid and, in some cases, the creatinine, were determined. The diet was constant and either purine-free or contained a fixed amount of purine derivatives. After it was proved that chocolate did not cause an increase of the uric acid this was included, in one case, in the food. Alkalies and some of their salts whose decomposition products make the urine alkaline were tried. Of these sodium bicarbonate caused no increase; lithium carbonate, a decrease; potassium acetate and sodium citrate, no change. Colchicum slightly decreased the uric acid. With both sodium salicylate and aspirin (the acetic acid ester of sali-

cylic acid) the uric acid of the urine was increased. One subject with chronic albuminuria, but otherwise no marked renal lesions, eliminated no more than the normal amount when aspirin was taken. Creatinine with all these drugs showed a remarkable constancy.

The Properties of Culture Media as affected by Certain Products of Plant Metabolism: Oswald Schreiner and J. F. Breazeale.

It was shown that certain products of plant metabolism, degradation products of proteids and lecithins, were harmful to seedling plants. Some of these products found in green plants lose their toxic properties on oxidation and become beneficial. It was pointed out that this explained the advantages of green manuring over mineral fertilizers and the chemistry of green manuring was discussed in this connection.

On the Increase in Weight in the Hydrolysis of Casein: J. H. Long.

By the digestion of casein and other proteins by action of pepsin and hydrochloric acid an increase in weight follows from the absorption of water and the addition of molecules of the acid to form salt-like bodies with the products of hydrolysis. In this paper the author describes a series of experiments in which casein was treated through a period of about five weeks with pepsin and dilute hydrochloric acid at a temperature of 40°. The digestion mixture was distributed through a series of flasks and from time to time one of these was removed from the thermostat and used for tests. The residue on evaporation was determined and in this the combined hydrochloric acid. The titration values by aid of dimethylaminoazobenzene, phenolphthalein and *p*-nitrophenol were also found. By combination of all these data from the whole series of mixtures an attempt was made to show in tabular form the rate of addition of water and acid throughout the digestive period.

The author called attention also to the value of *p*-nitrophenol as an indicator in the titration of digestion mixtures, an application which seems to have been quite overlooked.

Further Experiments on the Composition of Feces Fat: J. H. Long.

In previous papers by the author attention has been called to the large phosphorus content of the purified fat from the feces of individuals in normal health. This paper presents the results of a lengthy series of experiments in which the characteristics of feces fat are more fully worked out, and especially of the portion which may be described as a body, or mixture of bodies, of the lecithin type. It was found that a large fraction of the fat could be precipitated from alcohol solution by cadmium chloride and from ether solution by acetone. Nitrogen and phosphorus were determined in the fractions precipitated by acetone, and in the fraction not so precipitated. It was found that practically all the phosphorus was contained in the acetone precipitate, while the nitrogen was present in both. A part or all of the nitrogen may have been split off from the original complex, however. The ratio of phosphorus to nitrogen was determined in the original fat, and in the several fractions; also the iodine members, the saponification equivalents and other constants.

The Influence of Alcohol on the Excretion of Inorganic Constituents of the Urine: F. C. Hinkel and Wm. Salant.

Fifty cubic centimeters of 50 per cent. or 70 per cent. alcohol given by mouth to a healthy dog caused a diminution of chlorides—about 22 per cent. The phosphates were diminished about 40 per cent.

Total sulphates were decreased during the alcohol period about 36 per cent. After alcohol was discontinued the urinary chlorides returned to the normal. The phosphates likewise increased in amount, but at the end of ten days the daily total was about 15 per cent. below the daily average for the control period.

A Study of the Effects of Cerium Salts and of Salts of Some Related Metals: GEORGE BAEHR and HARRY WESSLER.

Cerium oxalate was administered to dogs in relatively large doses for days, occasionally as much as 50 grams at a dose, without eliciting any symptoms beyond a slight increase in the amount of feces evacuated daily, a symptom following the administration of any inert powder in large quantities. The oxalates of neodymium, praseodymium, lanthanum and thorium, all of which are associated as impurities in commercial cerium oxalate, were also absolutely non-toxic. As to the efficiency of cerium oxalate in alleviating vomiting, when induced artificially by drugs acting either locally on the gastric mucosa or centrally on the medulla, our results up to date are not conclusive enough to permit us to decide, but apparently, except in large doses, it has little or no influence on vomiting. The action of cerium oxalate seems to be simply mechanical and local on the gastric membrane. Cerium nitrate, as a soluble salt, combines readily with protein and when injected hypodermically in dogs, a large ulcer was always formed around the site of injection. Besides this, a few days after the injection intense gastro-intestinal disturbances occurred, such as vomiting and diarrhea which was sometimes very bloody. The autopsies showed an unusual violence of the gastric and intestinal peristalsis and an empty gut, the mucous membrane of which was markedly congested and in places ecchymotic. The assumption is justifiable that at least a large part of the cerium in such cases must be eliminated from the body through the alimentary tract.

The Solubility of Acetanilide, Phenacetine, Caffeine and Salol in Several Organic Solvents: ATHERTON SEIDELL.

The author has determined the solubility at room temperature of these common constituents of headache powders in acetone, benzene, benzaldehyde, amyl alcohol, amyl acetate, aniline, acetic acid, xylene and toluene. Salol may be removed almost completely from a mixture of all four of the substances by either toluene, xylene or benzene, and acetanilide and phenacetine can be removed fairly satisfactorily from their mixtures with caffeine by means of amyl alcohol or acetate.

The Effect of Caffeine on the Contractions of the Different Parts of the Ureter: D. R. LUCAS.

Medium-sized dogs were narcotized by subcutaneous injections of 0.006 gm. of morphine and 0.001 gm. of atropine per kilo of body weight. Venous perfusion of one per cent. caffeine sulphate in Ringer's solution caused the pressure in the renal pelvis to rise steadily; the tracing was surmounted by small curves, the rise in pressure continued for thirty to ninety seconds, the pressure in the straight portion remained unaltered, until at the end of the time indicated a sudden reversal of pressure took place, several smaller variations from normal pressure followed in both parts of the ureter, and the relative pressure in the different parts was finally reestablished. However, the frequency of contractions in each portion continued at an increased rate. The stimulating effect of caffeine on the ureter was studied in a series of experiments which were planned entirely to eliminate the factor of renal secre-

tion. The kidney, ureter and adjacent portion of the bladder were excised, *in situ*, and placed in a bath of warm Ringer's solution. The caffeine was used by suffusion or perfusion. The stimulating effect was observed by the graphic method. When solutions containing 2–5 per cent. of caffeine were used, tonic contractions took place that lasted one to three minutes, after which the peristaltic waves were much smaller and more frequent. In both series of experiments the stimulating action of caffeine caused the pelvis to contract in a tonic manner, the isthmus apparently exerting a sphincteric action, which prevented the urine from passing until the constriction was overcome by the increasing pelvic pressure, at which time equilibrium in the tone of the different parts was reestablished.

The Occurrence of Manganese in the Fresh-water Clam: HAROLD C. BRADLEY.

Manganese has been found in considerable amounts in the tissue ash of specimens of the common fresh-water clams of the Mississippi Basin—*Unio* and *Anadonta*—obtained from the lakes at Madison, Wisconsin. It was suspected in the first instances that the manganese might be present in the intestinal tract, from manganese bacteria ingested with the food; but after six weeks starvation the apparent amount of the metal in the ash was unchanged. It seems probable, therefore, that manganese is normally present in these molluscs. Further examination shows it to be regularly present in the blood and eggs, while iron is present in small amounts and copper only in minute traces. The presumption seems warranted that the respiratory exchanges of *Unio* and *Anadonta* are carried on by a manganese-proteid combination analogous to the iron and copper compounds, hemoglobin and hemocyanin, and the less well-known copper and zinc combination, hemosycotypin.

The Hexone Bases in Camembert Cheese: ARTHUR W. DOX.

Studies on the Metabolism and Physiological Function of Phosphorus Compounds: W. H. JORDAN.

On Protein Analysis: P. A. LEVENE, W. A. BEATTY, R. D. MACLAURIN and C. H. RUILLER.

On the Influence of Internal Hemorrhage on Chemical Changes in the Organism, with Particular Reference to Proteid Catabolism: F. S. WEINGARTEN.

Two dogs were subjected to the conditions of internal hemorrhage by transferring measured volumes, about 3 per cent. of the body weight, of blood from the femoral artery to the peritoneal cavity. This was done respectively six and seven times, the dogs having first been put in nitrogenous equilibrium and fed each day with the same amount of food of known composition. Due surgical care was observed, the dogs kept under excellent conditions, and urine and feces collected each day. From the first there was a steady decline in weight, although all food given was eaten. The second dog did not regain his weight till six months after the seventh operation. At autopsy neither dog showed blood in the peritoneal cavity, there was no matting of the omentum; the only marked change was the thickening of the abdominal wall after the numerous laparotomies and one band of adhesions between the stomach and the left parietes. Collateral circulation had been prompt and effective in the legs. Daily urine volume showed marked changes, there being a decided fall on the day of hemorrhage and a very marked increase from two to four days later. The average of daily nitrogen in the urine was about the same at the end as at the beginning of each

series, having increased for the first few periods, then decreased. The average for the first three days of each period was less than that for the whole period, and more than for the last three days of the period. Similarly, the average for the last three days of a period was less than the daily average of the period. Comparison between total nitrogen ingested and excreted showed that for the first few periods in each series the amount excreted was greater than that ingested, while toward the end the reverse was true. Apparently, in the first case, the nitrogen of the hemorrhagic blood was disposed of, or, if taken into the system, allowed greater elimination from other sources. When the animals felt the effects of the hemorrhages they no longer rid themselves of this extra nitrogen, but used it in the general economy. In the one exception to this a second hemorrhage followed the first so closely that the dog was possibly unable to work up its material.

The research was carried out jointly by B. B. Crohn and the writer along lines similar to those of a previous study of the effects of external hemorrhage.

On Iodomucoid: GUSTAVE M. MEYER.

Fairly concentrated solutions of tendomucoid in 0.5 per cent. sodium carbonate were set aside at 40° with several grams of pulverized iodine. Iodine was added from time to time, so that an excess was always present during the first twelve hours. Warming was then continued until no particles of iodine were noticeable. The liquid had a deep red color. After filtration, the iodomucoid was precipitated with 0.2 per cent. HCl. The precipitate was purified by repeated washings with water, alcohol and finally with ether. A yellow powder was thus obtained, which contained 14 per cent. of iodine. The other halogens were absent. The substance otherwise possessed all of its previous protein properties. It could be redissolved in dilute alkali and precipitated without loss of iodine. Details of further study will be reported later.

A Preliminary Report on the Toxicity of Some Artificial Dyestuffs: GUSTAVE M. MEYER.

A number of commercial dyestuffs commonly used as food colorants were studied in a preliminary way as to their general behavior when administered in different amounts to dogs, with a view of selecting one or more pigments best suited for a further study of effects on metabolism. The coal-tar colors thus far studied are: curcumin *S*, tartrazine, naphthol red *S*, carmoisin *B*, naphthol yellow *S*, gold orange and ponceau 2*R*. The effective amount, or the quantity causing sufficient disturbance to warrant a discontinuance of that dose, varied from 0.83 gram per kilo body-weight for curcumin, to 7.69 grams per kilo for ponceau 2*R*. By way of comparison, it was found that the effective amount of potassium sulphate was 1.75 grams per kilo of body-weight. Ponceau 2*R* is the only one which appeared to be poisonous in the doses given. One animal succumbed after the administration of comparatively small amounts of this dyestuff (2.9 gm. per kilo of body-weight) whereas another animal was unaffected by much larger amounts (7.69 gm. per kilo). In general equally large amounts of various saline purgatives or even many substances commonly regarded as innocuous, gave effects similar to those following the use of the colorants mentioned. These dyestuffs were absorbed only to a slight extent and, therefore, their elimination through the urine was not very marked. The larger part of the ingested dyestuff passed off unaltered in the feces. This was particularly true when an excessive dose of material had been administered.

On the Excretion of Barium: GUSTAVE M. MEYER.

On Alkaverdin, the Coloring Matter of the Purple Pitcher Plant, Sarracenia purpurea: GUSTAVE M. MEYER and WM. J. GIES.

The carefully selected leaves of the plant were cut and dried, and then extracted with 95 per cent. alcohol. The alcoholic extract was concentrated by evaporation, with repeated additions of water to precipitate the chlorophyl, then filtered and finally evaporated under reduced pressure at a low temperature. Heating the alcoholic solution seemed to have little effect on the pigment, but continuous heating in the presence of considerable water caused chemical alteration of the coloring matter. The residue thus obtained is a perfectly clear, red, resinous mass, soluble in water, but insoluble in absolute alcohol and in ether. It could not be induced to crystallize. The substance is free from nitrogen. The aqueous solution reduces Fehling's solution and yields glucosazone with phenylhydrazine. With benzoyl chloride a bulky benzoyl derivative was obtained. Dilute aqueous solutions are changed in color by acids and alkalies. Alkali produces a deep green, acids discharge the color. This indicator can be used for acidimetry and alkalimetry under conditions similar to those that apply to litmus. The decided change from the green to colorless condition on the addition of acid is, however, far more delicate than the change of litmus from blue to red under similar circumstances. The delicacy of this indicator is not affected by the presence of neutral salts.

On the Formation of Sugar from Amino Acids: WM. SALANT.

Experiments carried out on rabbits in which phlorhizin diabetes was induced, have shown that glycocoll administered subcutaneously or by mouth is not followed by an increased elimination of sugar.

A Biological Method for the Detection of Fluorides in Food Products: S. AMBERG and A. S. LOEVENHART.

Loevenhart and Peirce have recently shown that sodium fluoride even in very minute quantities greatly inhibits the hydrolysis of esters of the lower fatty acids by extracts of different animal tissues. The effect of a large number of other substances representing widely differing classes of compounds on the hydrolysis of the esters has been studied, with the result that no other substances have been found which have an inhibiting effect comparable in extent with that shown by the fluorides. Ammonium fluoride and hydrofluoric acid act quite similarly to sodium fluoride. It occurred to us that a simple and delicate test for fluorides might be founded on these observations. Clear liver extracts were prepared by the method of Loevenhart and Peirce and the activity of 1 c.c. of this was tested by diluting with 4 c.c. of water and adding 0.26 c.c. of ethyl butyrate and toluene. After acting for 16 to 24 hours at 35° to 40° the increase in acidity was determined by titration with N/20 NaOH. Simultaneously with the above test, experiments were performed in which the filtrates, neutralized if not already neutral, from various food products were used in place of the water in diluting the 1 c.c. of extract to 5 c.c. Other experiments were also simultaneously performed, using the filtrates of food products to which sodium fluoride had been added in various quantities. Working in this way, we have found that sodium fluoride when present in milk in a concentration of 1:5,000 caused an inhibition of 89.5 per cent.; 1:100,000 caused an inhibition of 87.8 per cent.; 1:1,000,000 caused an in-

hibition of 66.5 per cent. in the production of acid. Slight variations were noted with different extracts. Similarly we have found that the presence of 6 mg. of sodium fluoride in a kilo of meat can readily be detected by using the boiled aqueous extract of the meat in diluting the extract. In some cases, as with grain and beer, it is necessary to ash the product in order to concentrate the fluoride and destroy certain organic substances which when present in large quantities inhibit the action of the enzyme. A more detailed account of these experiments will soon appear.

The Elimination of Radium in Normal and Nephrectomized Animals: WM. SALANT and GUSTAVE M. MEYER.

Radium bromide was injected subcutaneously into dogs, and normal and nephrectomized rabbits. The bile, feces and intestinal contents of a dog provided with a permanent and complete gall bladder fistula were found radioactive two hours after the injection of radium. Radium bromide was also injected into a dog with a temporary biliary fistula under ether narcosis. The urine, bile, and contents of the small intestine were radioactive. Radium was not found in the contents of the large intestine. The gastric contents of these two dogs failed to show the presence of radium. The elimination of radium in rabbits takes place all along the intestinal tract, but not in the stomach. In one of the nephrectomized rabbits radium was absent in the contents of the large intestine. The presence of radium was determined by the electrometer. The materials tested were heated to destroy induced radioactivity.

A Study of the Elimination of Casein in the Bile: WM. SALANT.

Hallauer and Gürber claim to have found large quantities of casein in the bile of rabbits after injection. The elimination of native or foreign proteids in the bile has recently been made the subject of several investigations. Brauer claims to have found albumin in the bile of the dog after poisoning with amyl alcohol. Pilzecker states that large quantities of albumin are found in the bile of dogs poisoned with phosphorus or arsenic. Hallauer and Gürber injected intravenously a solution of casein into rabbits; the bile of these animals when tested with rennin showed the presence of casein soon after its administration. A critical analysis of these results convinced the writer that the subject needs further study before the conclusion may be drawn that proteins, native or foreign, are eliminated in the bile. Accordingly a series of experiments was carried out on dogs and rabbits into which milk or casein, or both, were injected intravenously and the bile was then tested for casein, in the way indicated above, with the result that none has been found. In some experiments 20 gm. of casein dissolved in sodium carbonate were injected intravenously into dogs. The bile was examined at short intervals for the next ten to twelve hours and failed to show the presence of casein.

A Study of the Conditions affecting Zymolysis: WM. N. BERG and WM. J. GIES.

Peptolysis of either fibrin, edestin or elastin is quantitatively unequal in a series of aqueous solutions of different acids under any uniform digestive conditions. Striking disparities in the velocity, quality and extent of digestion of these proteins occur in solutions of common acids, whether the acids are present in the solutions in *equal masses* (equipercentage), or in *equal numbers* of acid *molecules* (equimolecular), hydrogen *atoms* (equinormal), or hydrogen *ions* (equidissociated). Tryptolysis of fibrin or elastin is markedly unequal in equivalent solutions of bases. Among the

conditioning influences that were obviously influential in all our zymolytic experiments were the character, state and strength of the acid or base, the quality and concentration of the enzyme, the duration of the period of digestion, the temperature of the digestive mixture, and the nature of the protein. No doubt the different digestive products themselves exerted unequal influences as the proteolytic transformation proceeded. In experiments with fibrin and elastin to determine the effects of the zymolytic products of one of these proteins on the peptic digestion of the other, there was marked interference with the peptolysis of one or the other (or both) when samples of the two proteins were together in 0.2 per cent. HCl in the presence of small proportions of pepsin. The hydrogen ion is the favorable acid factor in peptolysis. The associated anions or molecules (or both) appear to interfere (as a rule) with the peptic process, and their divergent influences seem to account, in part at least, for the quantitative disparities noted in each digestive series of our experiments. It has been shown in our work, however, that *acetic acid molecules* are practically without influence, under ordinary conditions, on the peptolysis of fibrin or elastin in solutions of hydrochloric acid $M/20$—a suggestion that the purely *chemical* phases of the normal gastric digestive process are practically unaffected by vinegar in the proportions commonly ingested. The effects of acetic acid and of vinegar on the *secretory* process in the stomach will be investigated. In tryptolysis the hydroxyl anion is the favorable basic factor and the associated cations or molecules (or both) seem to exercise the deterrent influences. In general harmony with the observed digestive disparities, there were marked inequalities in the swelling effects on fibrin in every equivalent series of acid or basic solutions. Bloating influences on fibrin were due primarily to the acid or base, but were more pronounced in the presence of enzyme. Elastin did not swell perceptibly in either the acid or basic solutions employed, but did so in the latter when trypsin was present. In a given series of equivalent or basic solutions under uniform digestive conditions the degree and sequence of zymolysis of fibrin were strikingly different from those of the digestion of elastin. This fact necessitates the thorough study of the zymolysis of many proteins in samples of the same equivalent acid and basic solutions.

Putrefaction of Tendon, Collagen and Mucoid: D. E. Roelkey and Wm. J. Gies.

Unwashed tendon pieces undergo spontaneous putrefaction in distilled water, tap water and 1 per cent. sodium chloride solutions, under both aerobic and anaerobic conditions. The collaginous masses gradually undergo complete disintegration, although even after putrefaction has continued for about two months in a liquid teeming with motile bacteria, collaginous fragments containing unchanged fibers may be present. The putrefactive odors are very marked. Putrefaction at the end of the period noted, and in the liquids used, has been most advanced in the salt solution and least advanced in the tap water. Anaerobic conditions favored special velocity and extent of the changes. A study of the products of, and the conditions best suited for, the putrefaction of tendon is now yielding numerous results. Similar experiments have been begun with tendomucoid and tendocollagen.

A Further Study of the Chemistry and Pharmacology of Ibervillea Sonoræ: Julia T. Emerson and Wm. H. Welker.

Some of the largest tubers of *Ibervillea Sonoræ* were collected and an effort was made to ascertain their general chemical

composition, and to determine the nature of the substance or substances which account for the poisonous qualities attributed to them by the inhabitants of the regions in which the plant is found. Qualitative tests showed the presence of proteins, carbohydrates, fats, cholesterins, lecithins, alkaloid-like substances, inorganic salts and salts of organic acids. Quantitative determinations gave the following results: water 87.10 per cent., solids 12.90 per cent., organic matter 11.48 per cent., inorganic matter 1.42 per cent. Alcohol and ether extracts were made and the Stas-Otto method applied for the extraction of alkaloidal material. The alcohol and ether extracts showed toxic action on frogs. The material obtained by the Stas-Otto method failed to show any toxic action when administered per os or subcutaneously to a small dog. This material seemed alkaloidal in nature but could not be identified as any one of the known alkaloids. Tuber meat from normal tubers, from brown spotted tuber and the rind were fed separately to dogs in amounts up to 2 gm. per kilo of body weight without producing any apparent effects excepting marked diarrhœa. Some work now in progress is intended to determine whether any of the inorganic salts are present in sufficient quantity to produce the cathartic effect noted, or whether this action may be due to an organic acid.

The Effects of Salts of Some Rare Elements on Seedlings: ALICE A. KNOX and WM. H. WELKER.

The general method followed was that described by True and Gies.[2] Salts of the following elements were studied in this work: didymium, beryllium, erbium, lanthanum, cerium, neodymium, yttrium, cesium, and praseodymium. The comparative effects of the anions TeO_4, SeO_4 and SO_4 were also studied. The greatest molecular concentration points at which growth occurred during the first twenty hours and the least molecular concentration points where no growth occurred after the first twenty hours were carefully noted, and it was found that the increase in toxicity followed Mendeléeff's table almost mathematically, the toxicity increasing from group to group and also down each individual group with increase of molecular weight. Points of concentration where the growth reached that of the water control, where initial stimulation occurred, where maximum stimulation occurred and where the growth again returned to that of the control were noted. The results on these points were less sharply defined, as could be expected, when the high dilutions and the normal variation in the seedlings are considered. In general, however, the trend was along the lines of the periodic system.

[2] True and Gies, *Bull Torrey Bot. Club*, **30**: 390, 1903.

Studies of the Effects of Ions on Lipase: RAYMOND H. POND.

The study of lipolytic digestion has been very little in comparison with the attention that has been paid to amylolytic and proteolytic reactions. In the case of the two latter it has been found that dissociable salts inhibit digestion inversely as their decomposition tension. As the correlation mentioned has never been established completely an extension of the study to lipolytic digestion would seem profitable. A commercial product having been found to be very active in the saponification of ethyl butyrate some initial steps have been taken in the intended study. The activity of the enzyme can be satisfactorily expressed in the number of c.c. of *M*/20 KOH required to neutralize the fatty acid arising from the saponification of the neutral butyrate. A sample preparation would be 2 c.c. of a

solution of one gram of the enzyme powder in 100 c.c. of water + 2 c.c. of the toxic salt, for instance *M*/64, silver nitrate + 0.1 c.c. of the ethyl butyrate. The control would be an identical preparation except that boiling would occur before the addition of butyrate. The difference in acidity of two such preparations after a given period of digestion at a given temperature would express the amount of lipolytic activity possible in *M*/128, silver nitrate under the conditions of the test. Thus barium nitrate at a concentration of *M*/4 allows lipolytic activity, while a dilution of *M*/1024 is without any inhibitory effect. In the case of silver nitrate *M*/256 inhibits, *M*/512 allows and *M*/16384 is indifferent. The corresponding points for lead nitrate are, *M*/64, *M*/128 and *M*/8192. These figures show that the enzyme is very resistant to toxic salts. This may be due to proteid impurities. No certain stimulation has thus far been established though some figures have seemed to indicate it.

Further Observations of the Effects of the Rays of Radium on Plants: C. Stuart Gager.

Results previously reported led to the conclusion that the rays of radium and of other radioactive substances act as a stimulus to germination and growth, accelerating or retarding these processes according to the duration and distance of exposure, and the strength of the radium salt employed. Further experiments warrant a similar conclusion with respect to other plant activities, such as respiration, starch-making, geotropic response, etc. The growth of plants watered with radioactive water may be accelerated or retarded. The result varies, not only with the degree of radioactivity, but also with the species of plant employed. Growth may be accelerated in an atmosphere containing the emanation of radium. When pollen or ovules are exposed before pollination, or when exposure is made after fertilization of the egg, plants grown from the resulting seeds vary profoundly from the parent plants. The heritability of these variations has not yet been tested.

Some Chemical Notes on Specimens of American Amber: Wm. J. Gies.

The amber was discovered by Dr. Arthur Hollick several years ago, associated with fossil leaves in the cretaceous clays at Kreischerville, Staten Island. The various samples were quite different in color and transparency, but in each case closely resembled a well known variety of amber in hardness, color, specific gravity, etc. Pulverized portions of the most typical samples lost only 0.45 per cent. in weight on drying several days at 110° C. Ash content was only 0.1 per cent. Analysis indicated the following elementary composition: C, 78.5; H, 9.5; S, 0.25; O, 11.75. On destructive distillation succinic acid appeared to be formed and a considerable quantity of volatile sulphide was evolved. Long continued extraction in absolute alcohol and in anhydrous ether led to the solution of 42.6 per cent. of the powder in the former liquid, and 45.5 per cent. in the latter. The specimens appeared to consist of typical amber. Further observations on larger quantities are expected to clear up any doubt in this regard.

Effects of Acids on Tendon, with some Notes on the Preparation of Elastin, Collagen and Mucoid: Wm. J. Gies.

When sections of Achilles tendon are immersed in dilute acid, *e. g.*, 0.1 per cent. HCl, they become greatly bloated in a few hours. If the pieces are thin transverse sections to begin with, they swell to large semitransparent mulberry-masses. Such sections swell unequally in any series of different acids of equivalent concentra-

tions. The bloated masses are rigid and rebound when dropped on a hard surface. Although tendon is ordinarily very resistant to any process of maceration, the swollen masses produced by treatment with acid may be readily minced in a hashing machine. The hash thus produced forms with water a clear viscid mass, the whole of which may easily be pressed through cheese cloth, and in which the gelatinous particles are in great part indistinguishable. This viscid product bears a striking superficial resemblance to egg white, so far as consistency is concerned, but it lacks the yellowish tinge of fresh egg white. When such a viscid acid-tendon-water mixture is made alkaline, or a swollen piece of acid-tendon is dropped into dilute alkali, *e. g.*, half saturated lime water, transparency is quickly lost and there is a rapid return to the original white, opaque, *fibrous* condition of the material. This striking transformation may be brought about with great ease, even with pieces of tendon that have been immersed in acid for months. The alkaline liquid contains practically all the mucoid in the tissue. The collagen does not appear to be gelatinized or particularly dissolved. These facts furnish starting points for improved methods of preparing elastin, collagen and mucoid from ligament and tendon. This particular study was undertaken in an effort to discover the chemical state of mucoid in connective tissues. At present the results suggest a union in the tissues between collagen and glucoprotein. Further study of the phenomena alluded to and numerous physico-chemical influences on them, is in progress.

On a Glucoprotein from Tendon that is Non-precipitable by Acid: WM. J. GIES.

Tendon yields a water-soluble, acid-reacting glucoprotein product that may be extracted from that tissue with lime water, and which is non-precipitable by acid from such extracts. It is possible that this product is derived from the main mass of glucoprotein in the extract when the latter is acidified for precipitation of the traditional mucoid. Extended comparative observations of elementary composition, reactions, etc., will be made before an answer to this question will be offered.

New Studies of Mucoids and Nucleoproteins: (1) *Inorganic Salts;* (2) *Organic Salts;* (3) *Color Compounds;* (4) *Quantitative Determination:* WM. J. GIES.

Numerous *water-soluble* salts of mucoids and nucleoproteins have been made, such as salts of calcium, tetraethylammonium hydroxide, conine and azolitmine. As a rule the acid protein combines readily with the base, and the water-soluble compound may be obtained from the filtrate by precipitation with alcohol. An elaborate study of the chemistry of these compounds is now under way, including experiments on the electrical conductivity of the solutions, with the cooperation of Messrs. W. H. Welker, A. D. Emmett and J. Rosenbloom. The electrolysis of the salts and their pharmacological effects and various biological relationships are also being studied. It is impossible *completely* to precipitate either mucoid or nucleoprotein from alkaline tissue extracts by the usual acidification process, even when the greatest care is taken to prevent over-acidification. In the case of mucoid, for example, a loss of 20 per cent. or more of the material usually results with each precipitation by this method. The portion of the mucoid that is non-precipitable by acid may be precipitated from the filtrate by treatment with alcohol in moderate excess. All data heretofore obtained by various observers for the quantitative contents of mucoid in normal and abnormal tissues are incorrect —probably invariably too low. Mr. C. E. May is cooperating in a study of the quan-

titative determination of compound proteins in tissues.

Determination of Acetanilide in Headache Powders: Atherton Seidell.

The method consists in boiling the weighed sample of powder with 20 per cent. or stronger hydrochloric acid for about five minutes, by which treatment the acetanilide is converted into aniline hydrochloride. On titrating the hot or cooled solution containing a large excess of acid with standard potassium bromate solution a flocculent precipitate of aniline tribromide separates and as soon as an excess of the bromate solution is added the yellow color of the liberated bromine indicates the end of the reaction. Experiments showed that such substances as caffeine, salol, inorganic salts, etc., do not interfere with the accuracy of the titration, but that the presence of phenacetine or of antipyrine renders the method inapplicable.

Most of the papers presented at the meetings will be published later in the different chemical journals.

The meetings were well attended, and owed much of their success to the trustees and faculty of Columbia University. A unanimous vote of thanks was tendered to them and the Chemists' Club, to the College of the City of New York and to the different industrial establishments which the visiting chemists had been invited to inspect.

This report has been transmitted through Professor Charles L. Parsons, Secretary of Section C.

C. E. Waters,
Press Secretary.

SCIENTIFIC BOOKS

Inheritance in Poultry. By C. B. Davenport, Director of Station for Experimental Evolution. Publications of the Carnegie Institution of Washington. No. 52, 1906.

The important and extensive series of experiments with poultry, carried out by Bateson and Saunders and Hurst in England have shown the general application of Mendelian principles to inheritance in this group. These authors have demonstrated the relation of dominance and recession of many of the characters of poultry, showing, for example, the dominance of rose comb, white plumage, extra toe, feathered shanks, white and blue shanks, crested head, brown egg color, and broodiness; and the recession of leaf comb, single comb, black plumage, buff plumage, normal foot, clear shanks, uncrested head, white egg color, and non-broodiness. The same investigators have likewise shown that Mendelian splitting occurs in the second generation, and have referred the results to Mendel's hypothesis of segregation in the gametes of the first generation of hybrids. They have also drawn attention to the fact that the dominance of characters in poultry is not always complete in the first generation. Hurst estimated, in fact, that incomplete dominance is twice as numerous as complete dominance. It was also observed that in the second generation there is often a mixing of the characters, so that it is difficult or impossible to distinguish the pure forms from the 'dominant-recessives.' In other words, there may be almost a continuous series in this generation. Such results are difficult to account for on the basis of 'pure' gametes, although a tendency towards segregation may be distinctly recognized. The case most difficult to explain in this connection is the inheritance of extra toes. Castle's recent experiments with polydactylism in guinea pigs have shown in fact that prepotency, rather than Mendelism, is a more important factor in this kind of inheritance. It looks as though certain individuals may transmit a given peculiarity differently from other individuals; and while the 'lump-sum' may often give an approximation to Mendelian expectation, the really important fact is not the chance result, but the prepotency of certain individuals in regard to the transmission of characters.

Professor Davenport's work covers in part the same ground as that of Bateson and his co-workers; in part, however, he has studied different characters and races, and has been

able to add many new and important facts to those already known. The present work is, however, to be looked upon rather as preliminary—a first instalment of the extensive experiments under way at Cold Spring Harbor.

It would seem that studies dealing with the hybridization of unit-characters relate to the field of heredity rather than to that of evolution. In fact, many evolutionists of the old school deny the applicability of such results to the theory of evolution. There seems to be here a difference of opinion, whether well founded or not the future will decide. The opening paragraph of Professor Davenport's paper leaves, however, no room for doubt as to his attitude in the matter. "Evolution proceeds by steps. These steps are measured by the characters of organisms. * * * Since the character is the unit of evolution it deserves careful study."

The paper before us consists of thirteen studies in hybridization with thirteen different races of fowls. The facts are presented with admirable clearness and conciseness, and despite the large number of details that the subject demands the matter is handled in a very attractive way. The seventeen plates of photographs add materially to the interest and importance of the work.

For the detailed results of the author's experiments, the original paper should be consulted. It must suffice here to give a few of the more salient points.

When the single-comb, black Minorca is crossed with the single comb black Polish fowl "no characteristic [character?] is inherited in strictly Mendelian fashion, for, in no case is dominance complete." In the second generation twenty-four individuals were wholly black, and twenty-five wholly black and white or mosaics. "I interpret this irregular result to be due to the imperfect dominance of black."

When the single-comb, white Leghorn was crossed with the Houdan, the offspring were white with traces of black on one or more feathers. When inbred, these hybrids produced 18 per cent. pigmented individuals like the Houdan,—the Mendelian expectation being 25 per cent.—and the rest of the offspring was in part pure white and in part impure white. The former proved to be all males and the latter females! Other characters also, nostrils, muff, beard, crest, polydactylism, etc., show the influence of both parents in the first generation, and incomplete dominance and recession in the second, although a tendency to separate into Mendelian groups may be detected.

In the next cross, Houdan by Minorca, the author states: 'Striking is the nearly universal imperfection of dominance.' Imperfect dominance is also recorded for many characters of the five crosses that are next described, but since the experiments were carried only to the first generation, the results are still too incomplete for satisfactory interpretation.

An interesting cross was made between the Japanese Tosa fowl and the white Cochin bantam; the former race is characterized by abnormally long tail coverts. The first hybrids were like the Tosa fowl, although the tail was intermediate; every feather of the male was barred with white and in the female the shafting was broadened. In the second generation 28.1 per cent. were white to 71.9 per cent. pigmented individuals, but of the sixteen white individuals only five were without reddish pigment. "The forty-one pigmented individuals show a curiously mixed lot of coloration." One showed a Partridge Cochin plumage which must have 'lain latent in the white Cochin.' It is important to notice that in this cross white is not dominant in the first generation as with most other races of fowls.

The following four crosses were carried through the first generation only. They show, nevertheless, the complete dominance of frizzling; the incomplete dominance of the white of the white Leghorn over red of the game; the complete dominance of long tail over rumplessness (although one chick had no tail!); incomplete dominance of the black of the Cochin bantam over the red of the game.

A clear and able summary and discussion follows the detailed account of the experiments. Unit characters are not regarded as rigid or immutable from the evidences of

hybridization in poultry. DeVries's distinction between varietal and specific crosses, based on their behavior in inheritance, does not hold, as is shown by contrasting the behavior of those characters that are new to the race with those that have been lost. Furthermore a similar comparison shows that deVries's view, that a patent character dominates a latent one, as color does albinism, is not always found to hold in poultry. Standfuss's idea, that older characters or species dominate, has been shown by Bateson and Saunders not to hold good, and Davenport is able to confirm their conclusion. Of nineteen characters examined nine old ones dominated and ten new ones. The result depends clearly on some physiological peculiarity of the character that has no relation to its antiquity. These and other conclusions of the author are of importance for a fuller understanding of the laws of inheritance.

This admirable study of Professor Davenport's gives promise of still more important work to follow when the history of the material is further worked out. The Carnegie Institution is to be congratulated on the high order of work accomplished under its auspices.

T. H. Morgan

Columbia University

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 629th meeting was held on February 16, 1907, President Hayford in the chair. The evening was devoted to a paper by Dr. C. G. Abbot, on 'Solar Radiation and Terrestrial Temperature.'

The speaker gave a general account of the work of the Smithsonian Astrophysical Observatory in recent years, including its two expeditions of 1905–1906 to Mt. Wilson. The means of observing solar radiation both in total, and for all parts of its spectrum, were briefly described, and bolographic spectrum energy curves extending from wave-length $0.37\,\mu$ to $2.8\,\mu$ were exhibited. Such curves are obtained in twelve minutes each, and a series of eight or ten, covering the hours from low to high sun, is secured on each favorable day. By means of the expression $\log d = m \log a + \log d_0$ (in which d and d_0 are ordinates of such curves for a given wave-length at the earth's surface and outside the atmosphere, respectively, m, is secant of the sun's zenith distance, and a the transmission of the atmosphere for zenith sun) the form of the spectrum energy curve outside the atmosphere is obtained. By means of diagrams it was shown how closely this straight line equation fits the observations, and further evidence of the trustworthiness of the formula as a means of estimating the transmission of solar radiation in the atmosphere is furnished by the close agreement of simultaneous Washington and Mt. Wilson determinations of the solar constant, though a mile difference of altitude and 3,000 miles difference of longitude is between the stations.

About sixty values of the 'Solar Constant of Radiation,' as determined by Mt. Wilson observations of 1905, were shown in a diagram, and the evident change of nearly eight per cent. in August, 1905, pointed out. It was stated that single determinations were thought to be accurate, relatively, to one per cent. for usually good Mt. Wilson days.

The average numerical value of the solar constant is believed to be 2.12 calories per square centimeter per minute; and high values obtained by Langley, Ångström, and others, as quoted in text-books, can be shown to be ill founded. Ångström, indeed, has himself withdrawn his value four calories, but it still continues to be quoted.

Observations of the reflecting power of clouds were described and preliminary results showing wide departure of clouds from ideal matt surfaces were presented. Attention was drawn to the very large amount of solar radiation lost by reflection of clouds to space, and the probability that variations of cloudiness may in many instances mask the effect of variations of the solar radiation. Inland stations, only, seem likely to yield trustworthy evidence of direct connection between variations of the solar constant and the terrestrial temperatures, but evidence was cited of a direct connection of the kind as shown in Mr. Langley's paper (*Astrophysical Journal*, June, 1904) where nearly one hundred stations over

the north temperate zone united, not only as a whole, but by groups separately, to show a marked fall of temperature immediately succeeding an observed fall of solar radiation. A large number of inland meteorological stations have been selected to furnish data for an examination of the probability of variation of solar radiation heretofore, and this material is being worked over at the Astrophysical Observatory, and will form a part of Vol. II. of its *Annals* now being prepared.

R. L. FARIS,
Secretary

THE CHEMICAL SOCIETY OF WASHINGTON

THE 172d regular meeting was held in the Cosmos Club, February 14, at 8 P.M. After the regular business, President Fireman brought before the society the subject of the advisability of appointing a local sanitary committee—"The chemist, like every other citizen, is vitally interested in the sanitary conditions of the locality in which he lives. But, more than any other citizen, he is qualified, owing to his particular training, to examine into, and form a true judgment of the sanitary conditions surrounding him. Self interest, and whatever altruism there is in each civilized person should impel him, especially the chemist, to take an active interest in observing how the local sanitary requirements are provided for." After discussing the subject pro and con, the president was authorized to appoint a committee of seven to advise the society on local sanitary matters, and the committee was instructed to report at the next meeting.

Mr. Sherman Leavitt then read a paper on 'The Manner in which the Alkaline Earth Metals are held in Solution by Carbonic Acid.' The writer gave an account of the investigation of the boiler-water supplies of several western railroads, in collaboration with Professor Keiser, of Washington University, St. Louis. This work, carried on during 1901–1904, showed that the methods for testing waters were not capable of giving the necessary information for properly softening waters for steam purposes. The results indicated that the calcium carbonate held in solution by carbonic acid, as an acid carbonate, required two molecules of carbonic acid instead of one. Later experiments were conducted in a temporary laboratory established in an ice plant, where the temperature was kept at 28° F. The investigator finally succeeded in isolating an acid carbonate of calcium which was found to decompose at about +2° C. On analysis, this compound gave a percentage of water and carbon dioxid gas corresponding very closely with a formula for the acid carbonate containing two molecules of carbonic acid in combination with one of calcium carbonate. Barium was found to give a similar compound with even more favorable results.

On February 16, Professor E. C. Franklin, of the Department of Physical Chemistry at Stanford University, delivered an address before the Chemical Society at the George Washington University on some of his researches regarding the reactions which take place in liquid ammonia. The speaker called attention to the fact that liquid ammonia was neutral and had properties in all respects analogous to those of water. The lecture was illustrated by charts and equations.

J. A. LECLERC,
Secretary

BUREAU OF CHEMISTRY

THE ELISHA MITCHELL SCIENTIFIC SOCIETY OF THE UNIVERSITY OF NORTH CAROLINA

THE 170th meeting was held in the main lecture room of Chemistry Hall on Tuesday evening, February 12, 7:30 P.M., with the following program:

PROFESSOR COLLIER COBB: 'Some Human Habitations.'

PROFESSOR JOSEPH HYDE PRATT: 'The Fishing Industries of North Carolina.'

ALVIN S. WHEELER,
Recording Secretary

DISCUSSION AND CORRESPONDENCE

THE 'FIRST SPECIES' AND THE 'FIRST REVISER'

THE vast extension of our knowledge of animals and plants has forced upon all investigators the necessity of reducing systematic nomenclature to law and order, and to eliminate from it all elements of personal

choice and personal favoritism. It has, moreover, shown that no rules or laws can be made binding by mere agreement. They must in the very nature of things represent the best possible adjustment, else later generations will cast them aside. Hence laws must be simple, clear, and as far as may be, free from exceptions.

As part of the nature of things, the law of priority has forced its way to acceptance. In like fashion the law of unchanging spelling and the rule that nouns spelled differently are different words, regardless of etymology, must become universal.

The chief point of variance now left is this: A genus is known by its type. In case an author of a genus names several species, but fails to designate one as type, how shall the actual type be determined?

In this case we have two possible methods, both resting on a logical basis. I do not count among these the rule of elimination, which in my judgment has never been defined in workable fashion, and, however defined, will never meet with general adoption.

These two methods are, in brief, that of the 'first reviser,' and that of the 'first species.'

In the first method, when a genus is left without type indicated, the genus rests with the first of the original species which any subsequent author may select as type. In the second method, the type, unless otherwise indicated, is the first species named under the head of the genus in question, by its original author.

The logical basis in the first case is this: No generic diagnosis is complete until a type species has been indicated. If the original author neglects this, the first of his successors who does it, completes the generic diagnosis, and the generic name in question must stand or fall with the species selected. The rule of elimination may be a handy device for the use of the first reviser, and as such it has been justly commended; but he does as he pleases, and from his decision, the type once chosen from among the original species, there is no appeal. That is, we have no appeal, unless we find an earlier 'first reviser,' in which case the act of the later one is null and void. This rule of the first reviser is probably more generally recognized than any other in systematic zoology and botany. It has been lately strongly supported by Dr. Charles Wardell Stiles. Objections to it are these: Often the first reviser overlooks the fact that a type was virtually or even actually indicated by the original author. This makes it necessary to reverse many time-honored decisions, in which the work of the reviser is better known than that of the original author. More often the first reviser fails to make his own position clear. Whether he has actually chosen a type or merely used a species of illustration is often a matter of doubt. Still worse, after we have followed the first reviser, we find that we had overlooked a still earlier one. As a result of this, no name of this sort is safe until all the returns are in and all the work of obscure authors has been examined. This is bad enough when the priority of names is in question. It is a trial to do it in the interest of the meaning of names as well.

The first species method rests on this principle; the application of a generic name should depend solely on data furnished by the author himself. If he fails to indicate a type species, either directly or in some one of the recognized methods, then the first species he mentions must be considered as type. If he mentions no species, directly or by implication, the genus has no existence. This rule has been lately adopted by the American Ornithologists' Union and a strong argument for it has been made in this journal by Mr. Witmer Stone.

There is no injustice in this rule. Its application rarely if ever admits of serious question. It does not involve any bootless investigation of the meaning or intention of subsequent writers. It would involve probably less change of accepted nomenclature than any other rule that can be framed. The first reviser, in fact, has usually chosen as type the first species named by the original author. The French school of zoologists, Lacépède, Cuvier and their successors as a rule have placed first as *chef de file* the typical species

of each genus. Those memoirs in which the type species is placed in the middle of a genus are, in general, systematic catalogues, not descriptions of new species. When a genus is first named, nine writers out of every ten place first a species they know and which they deem typical of the group in question.

For all these reasons, the writer thinks that the first species rule should prevail, though he would not strenuously object to the rule of the first reviser. In so far as the method of elimination sets aside both first species and first reviser, doing the work over again with every change in our views of generic limits, he feels sure that future systematists will have none of it.

DAVID STARR JORDAN

SPENCER F. BAIRD

THE following, which I have just come across in the 'Autobiography' of Moncure D. Conway (Vol. 1, p. 49) seems worth reprinting in SCIENCE. Conway was a student at Dickinson College, Carlisle, Pa., when Baird was professor of zoology there.

T. D. A. C.

Baird, the youngest of the faculty, was the beloved professor and the ideal student. He was beautiful and also manly; all that was finest in the forms he explained to us seemed to be represented in the man. He possessed the art of getting knowledge into the dullest pupil. So fine was his spirit that his explanations of all the organs and functions of the various species were an instruction also in refinement of mind. Nothing unclean could approach him. One main charm of spring's approach was that then would begin our weekly rambles in field, meadow, wood, where Baird introduced us to his intimates. About some of these —especially snakes—most of us had indiscriminate superstitions. Occasionally he would capture some pretty and harmless snakes, and show us with pencillings their difference from the poisonous ones. He even persuaded the bolder among us to handle them. * * * After Professor Baird went to reside in Washington I had opportunities of seeing him and his family often. Mrs. Baird was a lady of fine culture and much wit. Baird was very lovable in his home, and to the end of his life he remained a man in whom I never discovered a fault of mind or heart. He awakened in me a love of science, to which I had previously given little thought.

MONUMENT TO MENDEL

TO THE EDITOR OF SCIENCE: It may not be generally known that an effort is being made to erect a suitable monument to Gregor Mendel. The movement has the support of leading biologists both in Europe and in America. It is hoped that American biologists will use their best efforts to see that this country is not behind Europe in its appreciation of the remarkable work of this pioneer in a field which at the present time occupies so important a place in biology.

According to circulars just received from Professor Tschermak, Professor C. B. Davenport, Cold Spring Harbor, Long Island, New York, has consented to receive subscriptions to the fund.

While American scientific men are, generally speaking, not wealthy, I think we all appreciate fully the service rendered by Mendel, and should not only contribute according to our means, but should endeavor to induce those who have the means and are interested in the progress of science to do so.

W. J. SPILLMAN
U. S. DEPARTMENT OF AGRICULTURE

ASSOCIATED PRESS FAKES

TO THE EDITOR OF SCIENCE: The Associated Press cables us that Matteucci says that within a few weeks the earth is to strike the tail of Marchette's comet, with dangerous consequences to the world. Now does the Associated Press believe this, and has it made any provision against such catastrophe; or has it merely preempted the right to say 'I told you so'?

Every one recognizes the attempted scare as one of the vapid jokes of an Associated Press agent. No one is soft enough to be hoaxed, and no one has suffered from the stupid fake, except a few frightened invalids and that particular Press Association itself which allows its name to be used as guarantor for such folly. Luckily there are other press associations, whose reputations are above sending such stupid cablegrams, or making their patrons pay for such nonsense.

C. A.

SPECIAL ARTICLES

RECENT DISCUSSIONS OF THE ORIGIN OF GYMNOSPERMS[1]

The discovery a few years ago by Professors Scott and Oliver[2] of the relation of the Paleozoic seeds known as *Lagenostoma* to the stems of *Lyginodendron,* in itself perhaps the most important contribution of paleobotany to botany that has ever been made, appears to have inaugurated an era of speculation in England during which the ferns seem to be in danger of almost total elimination, if one may judge from some of these recent contributions to the literature, Professor Seward even bringing forward the Lycopodiales as the ancestors of the Araucarieæ and necessarily the balance of the Coniferales as well, as if to relieve the dwindling Paleozoic Filicales from the burden of standing godfather to too many modern lines of descent.

While yielding full appreciation of the remarkable discoveries so admirably worked out in connection with the Pteridosperms, it seems to the writer that the present is an opportune time for recalling that threadbare maxim 'to make haste slowly,' for while we observe a laudable conservatism when it comes to a mere 'impression,' a 'structure' seems to be a peg on which it becomes immediately necessary to hang a theory.

Aphlebiæ may indicate pteridospermous affinity as Professor Oliver has intimated, and exannulate sporangia may also suggest, to some, that the Eusporangiate ferns are absent in the Paleozoic, although this latter view is a rather sweeping generalization from Mr. Kidston's *Crossotheca Hœninghausi* and Miss Benson's *Telangium Scotti.* One is tempted to inquire whence came these structures? Were they evolved among the Pteridospermæ? or rather do they not furnish another illustration of what Mr. Worsdell styles the grain of truth which underlies Professor Seward's discussion, that "All groups of plants shewed the same organs because they had inherited them from common ancestors." While the presence of *Aphlebia*-like organs and exannulate sporangia may eventually be found to characterize the Pteridospermæ, they may with safety be considered to also characterize some of those members of the Filicales from which the Pteridospermæ took their rise. While I would not press the existing terminology of the Filicales too closely upon the generalized forms of the Paleozoic any more than I would consider the mammal *Phenacodus* a horse or a cow, still in our endeavor to get away from a too rigid terminology we are in danger of going too far in the opposite direction, and while it may perhaps be well to set the early Filicales apart under an ordinal name, that of Primofilices (personally I would prefer Eofilicales), it savors somewhat of Saporta's Pro-Gymnospermæ. Mr. Arber, however, seems to limit the proposed term to the Leptosporangiate Paleozoic ferns or their immediate ancestors so that the group might equally well be termed the Primo-Leptosporangiatæ, in fact his diagram (*Ann. of Botany,* fig. 1) shows that he 'does not consider the evidence for the existence of the Eusporangiatæ entirely satisfactory' until we come down to so comparatively recent a period as the Tertiary. The writer feels very strongly that the future will show this view to be a reactionary one. Personally I place more reliance on the resemblance of the 'frond genera' *Tæniopteris, Danæopsis,* etc., to modern forms, especially as the fructifications are known in several instances, than I do upon the suggestion that these latter may be the sporangiate organs of the Bennettiteæ the descendants of the Paleo-

[1] Oliver, F. W., 'The Seed, a Chapter in Evolution,' Pres. address to Botanical Section, Brit. Assn. Adv. Sci., York, 1906. Arber, E. A. Newell, 'On the Past History of the Ferns,' *Ann. of Bot.,* Vol. XX., pp. 215–232, July, 1906. 'The Origin of Gymnosperms at the Linnean Society' (a discussion by Oliver, Scott, Arber, Seward, Weiss, Worsdell and others), *New Phytologist,* Vol. V., pp. 68–76, 141–148, 1906. Seward, A. C., and Ford, Sibille, O., 'The Araucarieæ, Recent and Extinct,' *Phil. Trans. Royal Soc. London,* B, Vol. 198, pp. 305–411, 1906.

[2] Scott, D. H., and Oliver, F. W., 'On the Structure of the Paleozoic Seed *Lagenostoma Lomaxi,* with a Statement of the Evidence upon which it is Referred to *Lyginodendron,*' *Phil. Trans. Royal Soc. London,* B, Vol. 197, pp. 193–247, 1904.

zoic Pteridospermæ. This is surely replacing a probability by a possibility, and we are led to wonder if the filicinean standing of the modern Marattiaceæ will be the next point assailed. In this connection it may not be amiss to quote from Wieland's summary in his splendid study of American Fossil Cycads, just published,[1] he says: "Plainly the preceding résumé of the principal characters of the two great cycad groups as combined and showing their descent from Marattiaceous ferns of the Paleozoic, is not merely conclusive, but one of the great cornerstones upon which the conception of evolution can rest secure."

At the risk of being classed as an 'impressionist' I would maintain that impressions lacking the talismanic 'structure' are not without value, and that resemblances to modern forms, while they may sometimes be instances of homoplasy, are far from being 'of absolutely no value.' It should be borne in mind that structures concerned with the vital process of reproducing the plant species, particularly at a time when seed-bearing was being inaugurated, would be far more liable to show homoplastic variations than would the purely vegetative structures. And far from echoing Professor Seward's statement that at the Linnean Society discussion too great stress had been laid on vegetative and too little on reproductive organs, it would seem to me that the reverse has been the true case.

Dr. Scott's discussion, as usual, is admirable and only too brief in the printed report. The novelties which he can always be depended upon to bring before his audience are facts of observation and not subjective. It may not be amiss to repeat his statement that he repudiated entirely the origin of the Araucarieæ or of any of the known Gymnosperms from Lycopods, and this leads us to a brief consideration of the more pretentious paper by Seward and Ford in the *Philosophical Transactions*. As a summary of existing knowledge of the fossil forms which may be or have been referred to the Araucarieæ, and as a contribution to our knowledge of the relatively little known living forms, this contribution contains much that is valuable, especially under the second head just mentioned.

As a possible illustration of the somewhat biased view-point assumed throughout, the fossil cone scales which have been referred to *Dammara* may be cited. With reference to all of these the authors say—"we fail to recognize any sufficient reason for this comparison." They quote Berry (1903) as seemingly concurring in Newberry's doubt regarding their relation to *Dammara*, which doubt they characterize as 'well founded.' This in spite of the fact that Newberry was quoted by me and his view discredited in the same paragraph, while in the next paragraph my suggestion of a further reason for doubting Newberry's view is quoted by the authors in another part of their paper (p. 380) as casting doubt upon Hollick's determination of Araucarian foliage from Cliffwood, N. J. While the facts are matters of no very vital importance in this connection, I may state that I have recently collected an undoubted Araucarian cone of large size from the New Jersey Cretaceous and foliage similar to *Araucarites ovatus* Hollick from the Cretaceous of North Carolina, and that I do not entertain the slightest doubt of their Araucarian affinities. Furthermore, in reference to *Dammara* in a paper published in 1904,[3] a copy of which was mailed to Professor Seward, I state that additional material had led me to remove the interrogation mark which Hollick had placed after the generic name in *Dammara Cliffwoodensis*. These details are only mentioned in this place to show the misconceptions, presumably present in other cases, arising from a misquotation of various authors. Happily Hollick and Jeffrey have recently shown[4] that the relationship of the *Dammara* scales, founded as it was upon external resemblance, is amply proven by the anatomical structure, although it must be confessed that this contribution does not seem to have greatly impressed the English authors if we may judge from their summation of its contents.

[1] Carnegie Institution of Washington, Publ. No. 34, August, 1906, p. 240.

[3] *Bull. Torrey Club*, Vol. XXXI., p. 69.

[4] *Amer. Nat.*, Vol. XL., No. 471, March, 1906.

When we come to consider the theoretical conclusions which Seward and Ford feel called upon to bring forward relative to the Lycopodian ancestry of the Araucarieæ, which conclusions are evidently those of the senior author, we cannot assent to any of them, and while it is expressly stated that they do not include the other Coniferales—the Araucarieæ standing far removed from them, it is impossible to understand, as has been already pointed out by Dr. Scott, how the Araucarieæ can be disassociated from their present position in the order Coniferales, which is an eminently natural group as it stands.

In conclusion to refer briefly to Professor Oliver's address on 'The Seed, a Chapter in Evolution,' it may be said that it is a delightful sketch of the possible origin of the seed-habit, couched in a popular style and full of pertinent and suggestive points.

Edward W. Berry
Maryland Geological Survey,
Baltimore, Md.

BOTANICAL NOTES

THE COLLECTION AND STUDY OF VEGETABLE GALLS

Botanists should not neglect the collection of vegetable galls of all kinds, whether caused by plant or animal parasites, since in either case the galls themselves are plant growths. These galls have been studied for some time by Dr. Mel. T. Cook, now of the New York Botanical Garden, Bronx Park, New York City, and he now asks all collectors to aid him in securing as many specimens as possible for his use. He asks that collectors bear the following suggestions in mind.

1. Many species of hard, woody galls should be dried and kept in boxes.

2. Most species of leaf galls should be dried in the same manner as herbarium specimens, except that the weights used should usually be much less—only sufficient to keep them straight.

3. Succulent species which lose their characteristic form in drying should be preserved in alcohol or formalin.

4. The host plant should be determined, or sufficient material sent to permit satisfactory determination.

5. The species should be wrapped separately in paper, or preferably in 'cheese cloth' so that any insects which mature in transit may be kept with their respective galls.

6. While galls produced by both insects and fungi are desired, it should be remembered that Dr. Cook is making a special study of the *galls* rather than the insects or the fungi. The work is strictly botanical, and he, therefore, appeals to botanists to aid him.

7. When the specimens are ready send them to Dr. Cook, at the address given above, accompanying them with an explanatory letter.

MORE PHILIPPINE BOTANY

The closing number (December) of the *Philippine Journal of Science* contains two articles of botanical interest, viz.:—'The Physiologically Active Constituents of Certain Philippine Medicinal Plants,' by R. F. Bacon, and 'Philippine Fibers and Fibrous Substances,' by G. F. Richmond. The latter is illustrated by several plates. During the year there have been printed in this publication eight botanical papers, and if we add those printed in the five supplements, the number is brought up to nineteen. These supplements, which have been wholly botanical, make a good-sized volume of themselves, covering about 400 pages. Added to the 1,100 pages of the *Journal* proper, the total result is about 1,500 pages of scientific matter for the year. As previously announced, the *Journal* will be divided hereafter, so that the botanical papers will constitute a series by themselves.

In the closing number of the 'Supplement' series E. D. Merrill contributes an interesting paper entitled 'An Enumeration of Philippine Gramineae, with keys to Genera and Species,' covering eighty-six pages, and including notices of seventy-two genera and 226 species and varieties. The paper is almost wholly based on material collected since the American occupation of the islands, and all species not verified by actual specimens are referred to the lists of 'doubtful or excluded' species, which are appended to the genera or tribes. Hackel's well-known monograph is followed rather closely in arrangement and nomenclature.

In looking over the tribes one finds many familiar genera, more than half being more or less common in this country. Thus one finds *Andropogon* (18 species), *Paspalum* (4 sp.), *Panicum* (34 sp.), *Setaria* (4 sp.), *Leersia* (1 sp.), *Sporobolus* (3 sp.), *Agrostis* (1 sp.), *Aristida* (3 sp.), *Calamagrostis* (2 sp.), *Diplachne* (1 sp.), *Eragrostis* (10 sp.), *Poa* (2 sp.), *Bromus* (1 sp.), etc. Four genera and thirteen species of bamboo (*Bambuseæ*) are recorded, but as to these the author states that his treatment is still necessarily incomplete, owing to the rare flowering of most of the species, and the unsatisfactory condition of the available herbarium specimens. The author concludes that 'on the whole, the Philippine Gramineae are strongly Malayan or Indo-Malayan, with a decided northern element in the highlands of northern Luzon, and a rather characteristic [north] Australian one.' In this connection the reader may profitably consult C. B. Robinson's paper on 'Some Affinities of the Philippine Flora' in the January number of *Torreya*.

Here may well be mentioned four pamphlets from the Philippine Bureau of Forestry, consisting of the annual report of the director, Major G. P. Ahern (including sixteen fine plates, most of which are of botanical interest); Bulletin 4 (including a paper on mechanical tests, properties and uses of thirty woods, and another on Philippine sawmills, lumber market and prices); Bulletin 5 (including a working plan for a forest tract on Negros Island, with twelve plates and a map); Bulletin 6 (including a working plan for a forest tract on Mindoro Island, with fourteen plates and a map). These bulletins contain much matter of interest to the general botanist, as well as to the forester.

EFFECTS OF SHADING ON SOIL CONDITIONS

THE Bureau of Soils of the United States Department of Agriculture has published a bulletin (No. 39) prepared by Mr. J. B. Stewart, on the effects of shading on soil conditions which is of much interest to plant physiologists. He shows that under the protection of a tent (1) the soil retains more moisture, (2) the temperature of the air is slightly warmer, (3) the relative humidity of the atmosphere is greatly increased, diminishing the transpiration of the plants and increasing their turgidity, (4) the velocity of the wind is reduced, still more reducing evaporation, (5) the plants make a larger, more rapid and earlier growth. The exact data for 1, 2 and 3 are as follows, in averages for the season:

	Inside tent	Outside tent	Difference
Soil moisture	14.7%	11.6%	3.1%
Temperature	72.8°	71.4°	1.4°
Relative humidity ..	79.0%	71.7%	7.3%

The growth of plants inside and outside of the tent is plotted on cross-section paper, showing very plainly that the plants in the tent grew faster and larger, and matured at an earlier date than the plants outside. The author points out, however, that "while the plants grew faster, and the leaves larger, the yield per acre was less by 100 to 300 pounds inside the tent than outside. This was probably due to the influence of the shade, which tends to make the surface of the leaves larger, but at the same time much thinner."

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

HENRI MOISSAN[1]

MEMBRE DE L'INSTITUT

BUT what I can not put into these successive chapters, is the joy I experienced in pursuing these discoveries. To walk in a newly-turned furrow, to feel one's self untrammelled, to see new subjects for study spring up on all sides, is so delightful that it can not be fully comprehended except by those who have experienced the ardent pleasure of research.

With this closing to a preface, Moissan throws open the door and invites us to participate with him in the discoveries made with the electric furnace. This most skillful of experimenters, having won his spurs in the conflict of isolating fluorine, thus distancing all others who had attempted the task, he attacks new problems with zeal, and the ability of an accomplished craftsman. He was truly

[1] Read before the New York Section of the American Chemical Society.

the embodiment of Davy's adage, 'It is the duty of the chemist to be bold in pursuit.'

Almost his last words as he left this city in 1904 was the terse sentence, 'Chemistry is still an experimental science.'

Moissan was born in Paris, September 28, 1852. He completed his education at an early age, his professional work being guided by Berthelot and Déherain. He was chief of laboratory at the École de Pharmacie in 1879. He attained his doctorate in science in 1885, presenting a remarkable thesis on the 'Série du Cyanogene.' This secured him the appointment of professor of toxicology at the school of pharmacy. He was elected a member of the Academy of Medicine, Section of Pharmacy in 1888, and made a member of the Academy of Sciences, replacing Cahours, in 1891. He was decorated with the Legion of Honor in 1886.

His earlier researches on the 'Oxides of Iron,' 1877, on 'Chromium and its Compounds,' in 1882, and on the 'Fluoride of Arsenic,' 1884, gradually led to his notable discovery of a method of isolating fluorine, in 1886.

His indefatigable pursuit of a problem is typically exemplified in a remark in his monograph on 'Fluorine and its Compounds': "And so after three years of research, I got to the first important experiment in the isolation of fluorine."

Another instance of his indomitable persistence will be remembered by some who were fortunate enough to hear his brilliant lecture, delivered at the College of Physicians and Surgeons, in 1896, when at the invitation of the New York Academy of Sciences, the American Chemical Society, the American Institute of Electrical Engineers, and the College of Pharmacy, he demonstrated the use of his electric furnace and showed his method of making diamonds. As he removed the glowing crucible from within the furnace and plunged it into a mass of water, some of his audience, all scientists, involuntarily moved as if expecting an explosion "Have no fear," said he, "I have performed this experiment without accident over three hundred times."

In friendly appreciation of the honors done him on that visit to the United States, he sent to the National Museum a collection of sixteen specimens of the products he had obtained by the use of this new instrument of research. The bottles were neatly closed with parchment and on each he had placed his signature. This collection will now be a unique record of his genius. During the same visit Moissan lectured at the Chicago University, and attended the sesqui-centennial celebration at Princeton. He made a study of our educational institutions and on his return wrote a report in which he dilated on the advantages our country was deriving from the liberality of her citizens towards the institutions of learning, and he exerted all his influence, which constantly increased, to bring about the same state of affairs in France, where because of the university belonging to the state, endowments were rarely forthcoming.

In 1889 he published some new researches on the 'Isolation of Fluorine,' and in 1890 he wrote on the 'Fluoride of Carbon.' He received the 'Prix Lacaze' in 1887.

His work on the fluoride of carbon led to his undertaking a study of all three forms of carbon, amorphous, graphite and diamond, and it was with the object of subjecting carbon to excessively high temperatures that he devised his electric furnace, a simple yet all-powerful instrument. With it he undertook a long series of researches on the elements and some of their compounds, the story of which would not only take us through many a chapter of science but also unfold the beginnings of a new art in chemistry. Later, together with Dewar, he liquified fluorine and showed how it would combine spontaneously with hydrogen, thus establishing, at least so far, the lowest temperature at which chemical union takes place. With his electric furnace he has demonstrated not only the indestructibility of many of the elements by the highest heat yet attained, for in a brilliant discourse given at Rome in 1906, at the International Congress of Applied Chemistry, he detailed his distillation of gold, the platinum metals, chromium, iron, nickel, manganese, tungsten, molybdenum and uranium, and be-

fore he had also demonstrated in the preparation of titanium carbide and other compounds that chemical combination took place at the highest temperatures at our command. What a technique! It is as if some master of the piano began at the base notes and swept up majestically to the highest treble!

Moissan studied particularly the chemistry of the elements. His isolation of calcium is a further example of new methods of attacking his favorite problem. At the International Congress at Berlin, he gave a lecture which charmed his audience and elicited the highest admiration. He presented his results on the hydrides of the alkalies and the alkali-earth metals. He added with these a further demonstration that hydrogen is not a metal, by showing that potassium and sodium hydrides, KH and NaH, do not conduct electricity, and are therefore not alloys.

We find him passing readily from the realm of inorganic to that of organic chemistry, producing potassium formiate, HCOOK by the direct union of KH and CO_2.

One can never read many pages of his memoirs without being struck with the fact that he made no sharp line of demarcation between the inorganic and the organic; to him they were but one chemistry.

With a host of collaborators Moissan was engaged to the last on a great work, 'Chimie Minerale.' A discourse given at the convocation of scientists at the St. Louis Exhibition in 1904, delivered at the invitation of the government, was a résumé of his introduction of this important treatise.

During the last few years Moissan had forged ahead. He was the president of the International Congress of Applied Chemistry in Paris in 1900. He had previously been appointed to Friedel's professorship at the Sorbonne, and with highest inspiration he was devoting his irrepressible energies to many problems. These were indeed multitudinous. His strictly scientific work was always paralleled with important applications for the well being of the human race. His originality showed him as a leader of thought and also a worker for his fellow beings, inaugurating new industries, planning new manufactures. Few chemists have had wider influence. A medal struck in honor of the twentieth anniversary of the isolation of fluorine was only recently given him by his students and friends.

The recognition of all this was freely given to him not only at home, for France is loyal to her sons, but also abroad; the last highest honor conferred on him was the Nobel Prize, for chemistry, in 1906.

But to those who came within the subtle influence of his personality the fact that an operation for appendicitis, which resulted fatally on February 20, 1907, has severed a friendship with one whose charm of manner endeared him to students, associates and friends alike, has come as a blow so sudden and unexpected that it is difficult to fully realize it. Our sympathy goes out to his noble wife, that faithful amanuensis, who has indefatigably taken down the thoughts of the adored husband and preserved them for us, and to the young man, his only child, who is devoting himself to the same profession.

Resolved, That the New York Section of the American Chemical Society respectfully request the council of the society to fully recognize the esteem in which our honorary member, Henri Moissan, was held by the members and associates of the society, and that appropriate resolutions be sent to his widow and son.

CHARLES G. DOREMUS

JOHN KROM REES

IT is the custom to mark the passing of a well-known man with a short notice of biography; and it is not difficult to recite a list of services, enumerate honors and distinctions conferred by public bodies, or recapitulate scientific researches and publications. But to the writer these things are cold and hard when said of Rees; to him Rees was known best as a friend—that rarest friendship whose beginning is outside the grasp of memory; whose end is a green sod.

Surely, if there exists a relation adapted better than any other to make one acquainted with the good or bad in any man, it is the relation of a subordinate to his chief. Dur-

ing eighteen long years the writer sat at his work under Rees: in all that time there never came down to him an unkind word; never once did a serious difference of opinion arise. In eighteen years one becomes accustomed to any man; the few like Rees one comes to love. These words will fail signally in their purpose, if they do not convey to his sorrowing family such poor consolation as may come from those who feel and suffer with them.

Rees was but fifty-five on his last birthday; in his short life he had served Washington University as a professor five years, and Columbia University twenty-one. He had been president of the New York Academy of Sciences two years, and secretary of the American Metrological Society fourteen years. For six years he was secretary of the Columbia University Council. He was a fellow of the Royal Astronomical Society of London, a member of the Astronomische Gesellschaft of Leipzig, and in 1901 was created a chevalier of the Legion d'Honneur in recognition of his services as one of the judges at the Paris exposition in that year. His principal observational research was a study of the 'Variation of Terrestrial Latitudes and the Aberration of Light,' made at Columbia University, in cooperation with the Royal Observatory, Naples. This was the first application of the method of simultaneous observations at two stations situated on the same parallel of latitude, but separated widely in longitude. The work was continued from 1893 to 1900: the method has since come into general use; and the International Geodetic Association, which includes all civilized governments, has now established four permanent stations to carry it on.

It was also during Rees's administration that the astronomical department of Columbia University undertook the publication of Rutherfurd's valuable series of star photographs. Through his efforts this enterprise was made possible; he took a keen interest in it, and spared no pains to further the work during a long series of years.

In educational matters Rees was at all times most active. His public lectures were frequent. Characterized especially by lucidity, they always attracted large audiences; people came to hear him again and again. But his most lasting contribution to educational development was his establishment of the Columbia summer school of geodesy. It is probable that he was the first to recognize practical field work in this subject as an indispensable adjunct in the training of civil engineers. Here he was at his best: his point of view always that of the genuine man of science, seeking ever the truth for its own sake; never exalting mere technique at the expense of theoretic perfection; never limiting his exposition of a subject to the side having most value from the financial point of view. Students frequently came back to him in later years; they always spoke of his summer school as the most agreeable memory of their college years. Whenever this occurred, Rees was a happy man for days.

At times Rees was persuaded to go beyond his quiet field of activity in the university. His most lasting public service to the nation was rendered as secretary of the Metrological Society, in furthering the introduction of standard or railroad time. The late Dr. F. A. P. Barnard, president of Columbia College, made the following reference to Professor Rees in his testament, dated 1886:

> I give to my friend, Professor John Krom Rees, the watch known as my Cosmic Time Watch, as a mark of my regard and of my appreciation of his zealous efforts for the promotion of metrological reform and for the introduction of the now established system of public standard time.

Rees's attitude towards the scientific work of others was one of extraordinary modesty. To him the past masters of astronomy were not men; they were demi-gods, to be mentioned in respectful accents and with lowered tones. Even living visible masters of the craft commanded from him a degree of respect such as he could not have offered even to crowned royalties. His own work might be as good as theirs, but he could never see it so.

Another marked characteristic was his extreme delight when visited by any one to

whom it was possible to do a favor. This was his pleasure. No trouble was too great or time-consuming; no return, not even thanks, was expected. No man ever had fewer enemies: his friends equalled in number those who knew him. When at last the heavy weight of disease was laid upon him he met it as a man should. No querulous repining: regret only that his work must stop; his solace that others would carry the good work on. Mother earth, that he loved well to measure and compute, will give him sleep; to him the peaceful end is surely a release.

HAROLD JACOBY

COMMISSION ON AGRICULTURAL RESEARCH

AT the meeting of the Association of American Agricultural Colleges and Experiment Stations at Baton Rouge last November a resolution was adopted instructing the incoming president of the association to appoint a commission of five persons to inquire into and report to the association on the organization and policy that should prevail in the expenditure of public money provided for experimentation and research in agriculture. It was provided that two of these persons should represent the research efforts of the association; one the United States Department of Agriculture, and two the scientific men not connected with agricultural investigations. The president of the association, Dean L. H. Bailey, of Cornell University, has appointed the following commission, the first two representing persons outside agricultural investigations, the second two representing the association, and the last representing the Department of Agriculture: David Starr Jordan, president of Leland Stanford University, *chairman;* Carroll D. Wright, president of Clark College; H. P. Armsby, director Pennsylvania State College Agricultural Experiment Station; W. H. Jordan, director of the New York State Experiment Station; Gifford Pinchot, forester, U. S. Department of Agriculture.

SEVENTH INTERNATIONAL CONGRESS OF PHYSIOLOGISTS

THE seventh International Physiological Congress will be held under the presidency of Professor A. Kossel in the Physiological Institute of the University of Heidelberg August 13, 14, 15 and 16.

Titles of papers and an exact list of apparatus or other articles required for demonstrations should be sent to the Physiological Institute at Heidelberg not later than June 15.

From August 12 to August 17 there will be held an exhibition of apparatus, by members of the congress, directors of physiological institutes and mechanics recommended by members or directors.

The official languages are French, German, Italian and English. The general secretaries are Professors Dastre (Paris), Fano (Florence), Grützner (Tübingen), Porter (Boston) and Sherrington (Liverpool).

THE CENTRAL BRANCH OF THE AMERICAN SOCIETY OF NATURALISTS

THERE will be held at the University of Wisconsin, Madison, Wis., on March 28, 29 and 30, 1907, meetings of the Central Branch of the American Society of Naturalists in affiliation with the Central Branch of the American Society of Zoologists, the Association of American Anatomists and the Central Branch of the American Society of Botanists. Each of these societies have an interesting program of papers and demonstrations. Papers will be read during the morning sessions on March 28 and 29 and demonstrations will be given in the afternoons. On Thursday evening, March 28, there will be a smoker for the affiliated societies and on Friday evening a dinner of the Naturalists and affiliated societies, at which time the address of the president of the Central Branch of Naturalists will be given by Professor J. Playfair McMurrich, of the University of Michigan.

SCIENTIFIC NOTES AND NEWS

LORD LISTER will celebrate his eightieth birthday on April 4, and it is proposed that to mark this event his scientific papers be col-

lected and published. Dr. C. J. Martin, director of the Lister Institute, Chelsea Gardens, London, S. E., will be glad to receive the names of those who desire to take part in this tribute.

The council of the Royal Society has nominated for membership the following fifteen candidates: Frank Dawson Adams, Hugh Kerr Anderson, William Blaxland Benham, Lord Blythswood, William Henry Bragg, Frederick Daniel Chattaway, Arthur William Crossley, Arthur Robertson Cushny, William Duddell, Frederick William Gamble, John Ernest Petavel, Henry Cabourn Pocklington, Henry Nicholas Ridley, Grafton Elliot Smith, William Henry Young.

Professor W. A. Tilden, F.R.S., professor of chemistry and dean of the Royal College of Science, London, has been elected a member of the Athenæum Club for 'distinguished services in science.'

Dr. George E. Hale, director of the Solar Observatory of Mount Wilson, has been elected one of the alumni members of the corporation of the Massachusetts Institute of Technology.

Dr. Frederic T. Lewis, of the Harvard Medical School, Boston, Mass., has been appointed editor of *The American Naturalist*. The editor desires contributions from 'all naturalists who have anything interesting to say.' Candidates for the higher scientific degrees are invited to contribute concise summaries of the special literature pertaining to their chosen topics. All manuscripts should be sent to the editor.

It is announced that the Carnegie Institution of Washington will erect the laboratory for the study of human nutrition which is planned adjacent to the Harvard Medical School. The work is under the direction of Professor F. G. Benedict, of Wesleyan University.

The Rumford Committee of the American Academy of Arts and Sciences has recently made the following appropriations in aid of researches on light and heat: To Professor F. E. Kester, of the Ohio State University, $315, in aid of his research on the thermal properties of gases flowing through porous plugs; and $400 to Dr. Harry W. Morse of Harvard University, in aid of his researches on fluorescence.

At Oxford University grants have been made from the Craven Fund of £60 to Mr. Günther, M.A., fellow of Magdalen, to assist his archeological investigations in Southern Italy; of £70 to Mr. Burrows, M.A., of Christ Church, to assist his investigations in Bœotia with a view to determining the site of the Delium; and of £40 to Mr. Dodd, B.A., University College, to assist his study in Germany of the coinage and history of the Antonine period.

The *British Medical Journal* states that the colleagues of Professor Ramón y Cajal and Professor Camillo Golgi, to whom was awarded the Nobel Prize for medicine, intend to mark their appreciation of the honor done their distinguished countrymen. On February 22 a meeting was held in the Colegio de Medicos, Madrid, at which it was agreed that a public subscription should be opened for a gold medal to be presented to Professor Ramón y Cajal; that a volume containing reports of original researches should be prepared under the direction of a committee consisting of Professors Calleja, Gomez Ocaña, Oloriz, Jimeno and San Martin, and that the government should be asked to confer a life senatorship on Professor Ramón y Cajal. The committee appointed to make arrangements for doing honor to Professor Golgi has decided that a scholarship bearing his name should be founded in connection with the University of Pavia.

Dr. John Collins Warren, who has been instructor and professor of surgery in the Harvard Medical School since 1871, will become professor emeritus at the close of the present year.

Dr. Raymond Pearl, instructor in zoology in the University of Pennsylvania, has accepted an appointment as biologist in the Maine Agricultural Experiment Station, Orono, Maine, beginning with the next academic year. The appointment is made under the

provisions of the Adams act. The work will be entirely research along the lines of plant and animal breeding. Especial attention will be devoted to an investigation of the principles of inheritance in poultry, a line of work which on its practical side has already been extensively developed by the station.

DR. FRIEDRICH MÜLLER, professor of medicine in the University of Munich, was tendered a complimentary dinner by prominent American physicians on March 8 at the University Club, New York. Dr. Francis P. Kinnicutt was toastmaster, and addresses were made by Drs. E. G. Janeway, A. Jacobi, W. H. Welch, L. F. Barker and by the distinguished guest. On March 9 Professor Müller spoke before the Harvey Society, and beginning on March 11 gave a series of six lectures on chemical pathology under the Herter foundation before the students of the University and Bellevue Hospital Medical College. He will visit Baltimore, New Haven, Boston, Albany, Montreal, Toronto and Cleveland.

PROFESSOR CHARLES S. MINOT, of the Harvard Medical School, has visited the Universities of Missouri, Kansas, Nebraska, Iowa and Louisville, and at each of these has delivered an address before the medical faculty and students on the new ideals of medical education for which the new laboratories of the Harvard Medical School stand. He also delivered before the Sigma Xi societies of the four state universities an address on 'The Biological Interpretation of Life,' speaking at Columbia, Mo., on the ninth of February; at Lawrence, Kansas, on the fourteenth; at Lincoln, Nebraska, on the sixteenth, and at Iowa City on the eighteenth. During his visit at Kansas University Professor Minot also delivered a course of three lectures on 'The Problems of Age, Growth and Death,' and a morning chapel address on the 'Functions of Consciousness.' At Louisville he participated as a representative of the university at the combined dinner of the Harvard and Yale Clubs, held on the evening of February 21.

PROFESSOR ROLAND THAXTER, of Harvard University, addressed the Botanical Club, on February 13, on 'A Botanical Trip to South America.'

PROFESSOR BECHTEREW, of St. Petersburg, has examined the brain of the late Professor Mendeléeff. It is said to weigh more than 1,200 grams, and to be remarkable for the number of its convolutions.

WE learn from the *Journal of the American Medical Association* that a research professorship in the Liverpool School of Tropical Medicine has been proposed as a memorial to Dr. Joseph Everett Dutton, who did valuable work in four successive expeditions sent out by this school to Nigeria, the Gambia, Senegambia and the Congo Free State. He described *Trypanosoma gambiense,* the parasite since recognized as the cause of sleeping sickness, and gained high distinction for himself and a world-wide renown for his school. While investigating tick fever, previously little known, he contracted that disease and died. The committee in charge of the fund says: "All who knew Dr. Dutton agree that the most fitting form which a memorial can take is one which will help to continue those researches in tropical medicine for which he gave his life." It is proposed to raise $50,000, and over $20,000 has already been pledged.

THE sum of $30,500, given by more than 760 alumni as a Shaler memorial fund, has been accepted by the president and fellows of Harvard University. The fund will commemorate the long and great services of Professor Nathaniel Southgate Shaler. A sum has been set aside to procure a memorial tablet to be put in the geological section of the University Museum, or some other suitable place; and the income of the balance will be used for the benefit of the division of geology in support of original research and in the publication of the results of research.

DR. ALLAN MACFADYEN, head of the Biological Department of the Lister Institute of Preventive Medicine and one of the leading English bacteriologists, died on March 1, at the age of forty-six years, from infection contracted in his laboratory.

The foreign papers state that the reporter of the inter-ministerial committee recently appointed by M. Barthou, minister of public works, to examine the various proposals for making a shorter route to Italy and to Central Europe has concluded in favor of the piercing of Mont Blanc. The report of the committee will now be discussed by the government, which will eventually propose a bill to parliament.

The Goldsmith's Company has contributed the sum of 1,000*l.* to the research fund of the Chemical Society, London.

A grant of £1,000 has been made by the Mercers' Company to the Imperial Institute for scientific research in regard to the economic products of British Colonies and Protectorates.

UNIVERSITY AND EDUCATIONAL NEWS

At the recent session of the legislature $25,000 a year was added to the appropriation for maintenance of the University of North Carolina and $25,000 a year for building and repairs. The annual appropriation for support is now $70,000.

The Alabama state legislature has recently passed a bill, since signed by Governor Comer, appropriating $400,000 for buildings at the University of Alabama (at the rate of $100,000 annually during this and the next three years), and $25,000 a year towards maintenance. The latter is a continuing appropriation. This is the first time in the university's seventy-five years' history that the state has made a distinct appropriation for the regular work of the institution.

In the state of West Virginia the new tax laws have yielded less revenue than the state has had formerly. The legislative appropriations for educational institutions have consequently been kept down to the level of previous years and have been further greatly reduced by the governor's veto. The state university, in spite of its recent rapid growth, receives considerably less than two years ago. To meet expenses the board of regents has been compelled to institute a system of tuition in the professional schools. The fund for salaries in the medical school was cut out by the governor and no way has yet been found for making good the deficit.

At the semi-annual meeting of the board of trustees of Princeton University on March 15, gifts amounting to more than $75,000 were announced. Among the gifts was one of $10,000 from Mr. Morris K. Jesup to increase the endowment of the Morris K. Jesup fund. Through the generosity of alumni the Carpenter building, situated on Nassau Street, has been purchased for the university.

At a recent meeting of the board of trustees of Carroll College it was announced that Mr. Andrew Carnegie had offered to give the last $25,000 of $100,000 towards increasing the endowment. It was reported that $75,000 had been pledged conditional, however, on raising a total of $175,000. It is expected that the full amount of $175,000 will be raised by June, 1908.

The Massachusetts Institute of Technology has received a further anonymous gift of $5,000 for the support of its Sanitary Research and Sewage Experiment Station.

Dr. Edward Charles Jeffrey has been promoted to a professorship of plant pathology at Harvard University.

Reginald Aldworth Daly, head geologist of the Canadian internal boundary commission, and formerly instructor in Harvard University, has been appointed professor of physical geology at the Massachusetts Institute of Technology.

Dr. A. D. Cole, professor of physics at the Ohio State University, has accepted a call to Vassar College, to succeed Professor Cooley who retires at the close of the academic year.

William D. Ennis has been appointed to the chair of mechanical engineering at the Polytechnic Institute of Brooklyn.

Dr. James Martin Beattie, senior assistant to the professor of pathology, University of Edinburgh, has been elected by the council to the chair of pathology, in the place of Dr. Cobbett. Dr. Cobbett resigned the chair on his appointment as lecturer on bacteriology at Cambridge.